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CARDIOSCOPY—SIMPLE AND PRACTICAL

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ONE of the most severe deterrents for intracardiac surgery has been our inability to visualize the interior of the heart. Several cardioscopes have been devised.[1-7] We are proposing a simple and efficient instrument for such purpose.

THE BOLTON CARDIOSCOPE

The instrument we have devised consists of a solid rod of Lucite (methyl metacrylate). The rod of Lucite has been shaped to the desired design by means of a lathe. After the proper design has been obtained, very careful polishing of the Lucite is done in order to obtain the highest degree of efficiency of light transmission.

The Bolton cardioscope may then be used without the necessity of additional light other than the usual source of available light at the operating table. This obviates one of the major problems with other types of cardioscopes. The property of Lucite to transmit light is very efficient.

The design of the cardioscope may be varied to suit the purpose. Our cardioscope consists of a tube of Lucite with a shaft which may vary in diameter from 0.75 cm. to 2 cm. The length of the cardioscope for use in the human heart is 10 to 12 cm.; for use in the animal laboratory, it is 9 to 10 cm.

The proximal end of the cardioscope is expanded to 5 cm. The edge is beveled, radiating from a flat center, equal to that of the diameter of the shaft, the bevel being about 30 degrees. This angle is sufficient to deflect a great amount of light into the shaft. The distal end of the shaft is oblique; this facilitates placing the distal end of the shaft against the structure to be inspected. A squared end surface of the distal extremity of the shaft has

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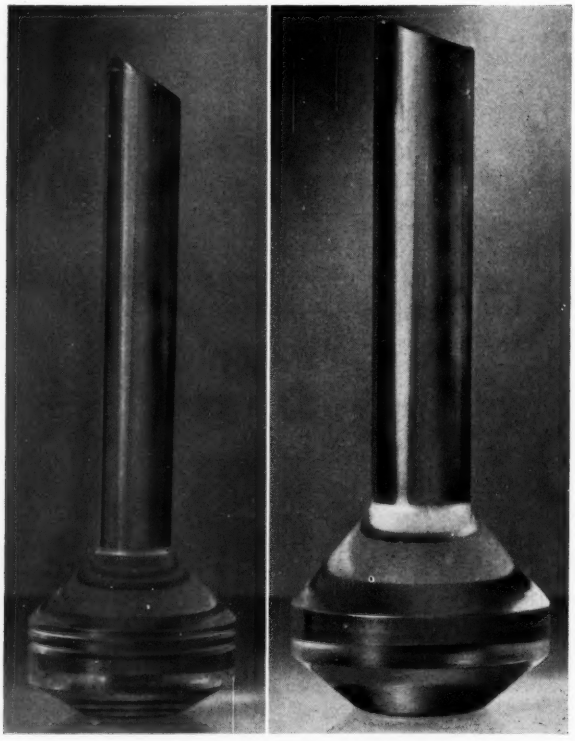
proved awkward in handling. A groove is placed at the proximal end of the cardioscope in alignment with the longer end of the obliquity of the distal end of the scope. (Fig. 1, *A* and *B*.)

The cardioscope may be designed to produce some degree of magnification by making the proximal end slightly convex.

The cardioscope has been designed in a variety of sizes in order that any situation may be dealt with when the necessity for variable sizes is required.



A. *B.*

Fig. 1.—*A*, Photograph of the Bolton cardioscope showing the oblique distal end uppermost and the expanded proximal end. Two grooves encircling the proximal end facilitate handling. *B*, A larger instrument which may be used to examine interatrial septal defects where there is a very large or redundant right auricle.

USES OF THE CARDIOSCOPE

Interatrial Septal Defect.—Perhaps the most significant use of the cardioscope is in the inspection of the interatrial septum (Fig. 2). The proper technical repair of an atrial septal defect may depend upon a satisfactory appreciation of the defect to be repaired. The tactile sense has been the best method for orientation[8]; however, when visualization of the outline of the septal

defect is possible, this facility adds greatly to the orientation necessary for repair of the defect. Dual defects of this septum are not uncommon, and some may be missed by digital exploration.

Atrial Septal Surgery.—Anomalous pulmonary veins are not an uncommon congenital abnormality. An associated interatrial septal defect usually coexists.[9] The size of these defects is variable and we have encountered instances in which the defect is small.

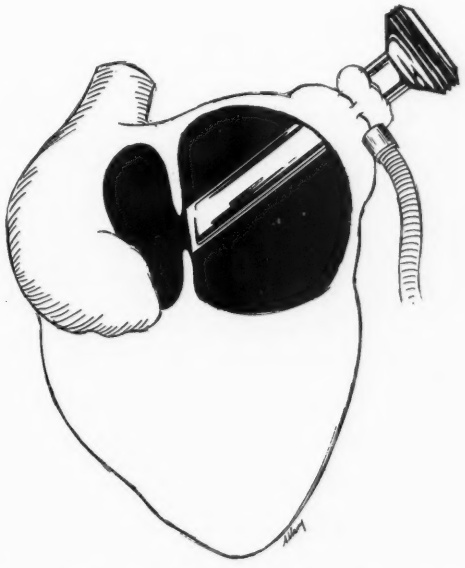


Fig. 2.—Diagram showing the cardioscope inserted through the left atrial appendage for inspection of an interatrial septal defect. The distal end of the scope must be pressed snugly against the atrial wall in order to have no blood between the end of the scope and the structure to be examined.

Our technique for performing atrio-septo-pexy for interatrial septal defects is versatile enough to perform a shunt of the stream of blood from the anomalous pulmonary veins (entering the right atrium instead of the left) through the atrial septal defect and into the left atrium. The septal defect may be so small that it cannot accommodate the flow of blood from the anomalous veins. In such an event, the endocardioscope with the knife attached may be used to incise the edges of the defect and enlarge it to an adequate size, prior to carrying out the atrio-septo-pexy. Of course, the position of the conduction mechanism must be kept in mind and use of the knife in this area must be avoided.

The instrument is inserted into the right atrium via the right atrial appendage, after the defect has been digitally explored. The defect is then inspected and the site of election for incision is determined. Radial incisions are

made (Fig. 3) and the row of sutures placed during atrio-septo-pexy are placed peripheral to the extent of incision, thereby shunting the blood from the lungs into the left atrium (Fig. 4).

Visualization of the Heart Valves.—We have encountered valve leaflet defects prior to our use of the cardioscope where observation of the defect would have been extremely useful, for example, a congenital perforation of the septal leaflet of the mitral valve.

Visualization of the Interventricular Septum.—We have not had occasion to use the cardioscope in the human heart to examine the interventricular septum; however, the ventricular septum has been completely visualized in the animal laboratory.

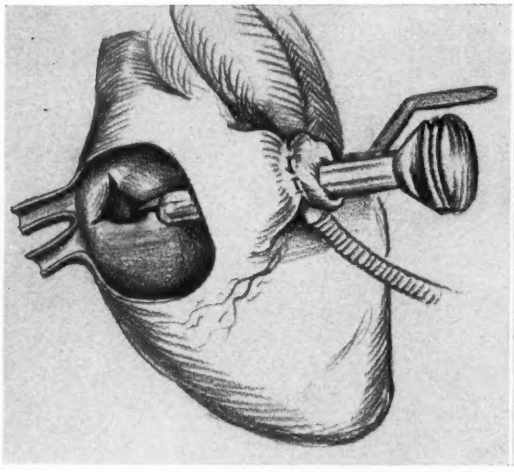


Fig. 3.

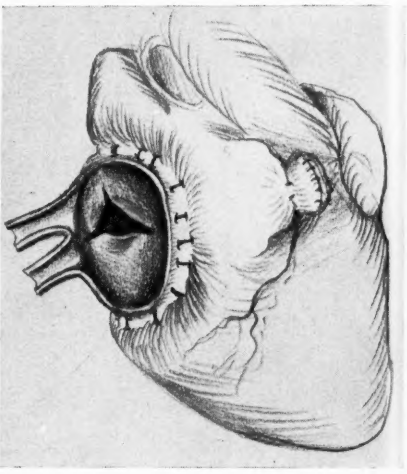


Fig. 4.

Fig. 3.—Cardioscope through right atrial appendage with knife protruded, radial incisions in septal defect; anomalous pulmonary veins entering adjacent to defect.

Fig. 4.—Atrio-septo-pexy; suturing wall of atrium to edges of enlarged defect, thus shunting blood from right lung into left atrium and closing septal defect.

The surgical treatment of ventricular septal defects has always been fraught with difficulty because of variation in the amount of "overriding of the aorta." For example, differentiating between the Eisenmenger complex, high ventricular septal defect, and Maladie de Roger may be difficult. In such cases, the surgical attack may be profoundly altered or guided by the location of the ventricular defect and its relation to the position of the aorta. Closure of the defect may be entirely precluded by a left ventricular outflow tract which would be severely obstructed by the methods of repair which are at our command today.[10] Likewise, visualization of the size of the ventricular septal defect is helpful in deciding upon the type of repair of the defect.

Infundibular Pulmonary Stenosis.—Treatment of infundibular stenosis always presents the problem of "how much of the infundibulum should be re-

moved." Appreciation of the amount of obstruction created by an infundibular septum (supraventricular crest) is greatly facilitated by an estimation of the size of the crest. If the Brock procedure is to be performed, a quantitative estimate of the amount of tissue to be excised is most helpful.

Use in the Animal Laboratory.—In the animal laboratory we have been able to inspect all chambers of the heart, and all valves. By inserting a small cardioscope into the left ventricle near the apex, it may be advanced along the outflow tract. By this means the aortic valve cusps may be viewed. We have also been able to inspect the coronary artery orifices by approaching the aortic valve from above (via an opening in the aortic arch).

Photography Through the Cardioscope.—We have found photography through the cardioscope feasible, but difficult because of the motion of the heart. When the heart rate is slow, we have been able to get a satisfactory photograph with use of the clinic camera, in about 30 per cent of the attempts. Attempts are being made to obtain cinematographic studies of movements of the intracardiac structures.

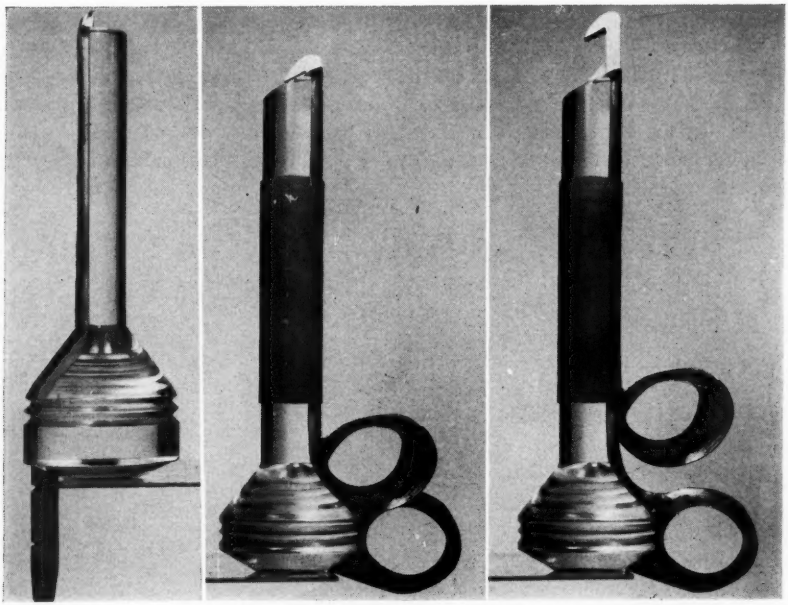
Fig. 5.—The cardioscope inserted through the wall of the left ventricle. Bleeding controlled with a purse-string suture through the ventricular wall and the instrument advanced to the interventricular septum; the outline of the septal defect followed by advancing the instrument around the edge.

TECHNIQUE FOR USE OF THE CARDIOSCOPE

For inspection of the atrial structures, the scope may be inserted into either the right or left atrium. The insertion is through the incision in the tip of the atrial appendage, using a tourniquet to prevent bleeding around the site of insertion. The oblique end of the instrument is then gently pressed against the structure to be inspected. This displaces the blood from between the instrument

and the structure. The instrument is then moved about in a systematic fashion to outline the edge of the defect or structure (Fig. 2). One must use the same precautions concerning obstructing the flow of blood as in any intracardiac procedure. The valves may not be occluded for longer than three heart beats.

During inspection of the interatrial septum, there is minimal obstruction to the flow of blood.



A. *B.* *C.*

Fig. 6.—*A*, Operating attachment (Gemeinhardt) with knife protruding from end of scope. This may be completely retracted or extended for 1 cm. A rubber sheath is used as in *B* and *C*. *B* and *C*, Guillotine knife inserted in a groove. A thin rubber sheath applied to shaft diminishes blood loss along groove for knife. Knife open (*C*) and closed (*B*).

Introduction of the cardioscope into the ventricle is through the wall at a level as near the apex as possible (Fig. 5). A heavy purse-string suture of braided silk is first placed deep in the ventricular musculature and the circle of the purse-string is made about twice the diameter of the proposed incision for insertion of the cardioscope. Secure hemostasis is thus provided. An incision of desired length is made and finger pressure controls bleeding until the scope is inserted. A cardioscope of smaller diameter is preferable for use in the ventricle because it necessitates a smaller repair of the myocardium. After the inspection is completed and the instrument is withdrawn, the incision is closed by two or three fine cotton sutures and the purse-string is removed, or definitive surgery performed.

One of us (W. G.) has devised attachments which are useful in the animal laboratory and may ultimately find many uses in the human heart. These attachments are useful in creating septal defects and valvular defects, and in dividing chordae tendineae or papillary muscles. One attachment consists of a knife (Fig. 6) which is projected from the distal end of the cardioscope for incisional purposes, and another is a guillotine type of knife for division of any structure which has a free edge (Fig. 6, *B* and *C*).

CONCLUSION

We have presented a cardioscope which is simple and practical for use in the human heart as well as for the experimental laboratory animal.

It is inserted into the heart with the same ease as an exploring finger.

Because of the efficiency of Lucite in the transmission of light, only the available operating room light is necessary.

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COMPLICATIONS ASSOCIATED WITH RESECTIVE OPERATIONS FOR PULMONARY TUBERCULOSIS

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IN RECENT years two things which have had a profound effect on the treatment of tuberculosis are: (1) the discovery and use of chemotherapeutic agents, and (2) the advances in thoracic surgery, physiology, and pathology. Our experiences with resective operations for tuberculosis prior to the use of streptomycin and to the advances in thoracic surgery serve to echo the experiences of other workers such as Sweet,[1] who has stated that his experiences have led him to conclude "that extirpative surgery is a procedure of limited usefulness in the management of the disease" and of Overholt and associates,[2] who have stated that the statistics of four or five years ago are now of historical interest only.

This study has been undertaken to examine our present and past experiences and, if possible, to utilize such analysis for the improvement of our future work. The place of resective operations will be determined by evaluation of (1) the risk involved in undergoing the operative procedures and (2) the late follow-up of patients who have undergone resective procedures. Since most of our experience with these operations has been acquired within the past two years it is too early to make a significant study of the latter factor. A study of the risk and complications of these operative procedures, however, seems warranted.

MATERIAL

Approximately 120 resections for pulmonary tuberculosis have now been done at Nopeming Sanatorium. However, in order to have a follow-up study of at least three months' duration for all patients, only those who underwent resections through Dec. 9, 1952, were included in this study. This period includes both the prestreptomycin era and the subsequent period. The study is based on a total of 110 surgical resections performed on 98 patients. The actual operations were done by seven different thoracic surgeons so that the results obtained represent a good cross section of results of different techniques of resection. Pneumonectomy was performed in 20 cases, lobectomy or bilobectomy in 30 cases, segmental resection in 44 cases, local excision or subsegmental resections in 10 cases, and combined segmental resection and subsegmental or local excision in 6 cases. For the purpose of analysis the last three procedures will be considered together.

In all cases operations were done with the patient under general anesthesia. In some cases local anesthesia was used in combination with general anesthesia.

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The patients were in various positions when operated on, including the prone, lateral, supine, and semiprone. This factor has been analyzed.

Our postoperative program has included close attention to intake and output of fluids, particularly in regard to intravenous administrations of fluid and transfusions of blood immediately after operation. By means of a portable machine, roentgenograms of the thorax were taken daily for the first few days until the patient was well stabilized with all drainage tubes removed. Aspiration of the pleural space to remove blood, fluid, or air and bronchoscopy to remove obstructing mucus were procedures used freely to maintain a smooth postoperative course.

RESULTS OF ANALYSIS

There were 47 men and 51 women in this series. The oldest patient was 57 years of age and the youngest 18 years. The majority of patients were 30 to 40 years of age. Ten patients underwent resections who had never received chemotherapy and did not receive it as part of their postoperative course. The remaining 100 resections were done on patients who had received streptomycin.

Forty-four patients suffered from complications. A study of the complications revealed that they could be divided into those due to tuberculosis and those due to surgical procedures (Table I).

TABLE I. COMPLICATIONS IN 44 CASES OF PULMONARY TUBERCULOSIS

	TIMES OCCURRING
Owing to tuberculosis (15 patients)	
Bronchopleural fistula with empyema	5
Spread to contralateral lung	3
Spread to ipsilateral lung	3
Contralateral exacerbation	2
Tuberculous bronchitis of bronchial stump	8
Infection of wound and empyema without bronchopleural fistula	1
Owing to surgical procedure used or to unrelated factors (29 patients)	
Atelectasis of remaining portion of lung	11
Surgical shock with death	3
Shock with cerebral damage	1
Nontuberculous empyema with bronchopleural fistula	3
Cardiac decompensation	1
Ruptured gastric ulcer with peritonitis and death	1
Guillain-Barré syndrome with death	1
Persistent pneumothorax pocket	10
Bronchopleural fistula without empyema	2
Hemorrhage	1
Massive subcutaneous emphysema with pneumonia and death	1
Reaction to transfusion	1
Severe ileus	1

As might be expected, the greater the amount of lung that had to be resected, the higher the rate of complications. Thus pneumonectomy carried the highest rate and segmental resection the lowest. This high rate of complications in relation to pneumonectomy is due not only to the greater loss of lung and its effect on the patient but also, and possibly even more so, to the fact that patients requiring pneumonectomy or lobectomy invariably had greater extent of disease

TABLE II. COMPLICATIONS WHICH FOLLOWED PNEUMONECTOMY, LOBECTOMY, AND SEGMENTAL RESECTION

	CASES
After pneumonectomy (13 patients)	
Surgical shock with cerebral infarction; recovery	1
Surgical shock with death	3
Contralateral exacerbation	1
Contralateral reactivation with stump bronchitis	1
Bronchopleural fistula with contralateral spread	1
Tuberculous empyema with infection of wound	1
Bronchopleural fistula	1
Stump bronchitis	2
Nontuberculous empyema with pleurocutaneous fistula	1
Atelectasis	1
After lobectomy (14 patients)	
Mediastinal and subcutaneous emphysema; reaction to transfusion; pneumonia; ileus; death	1
Stump bronchitis	2
Stump bronchitis; bronchopleural fistula	1
Atelectasis	3
Ipsilateral and contralateral spread; stump bronchitis	1
Cardiac decompensation	1
Bronchopleural fistula with ipsilateral and contralateral spread	1
Ruptured gastric ulcer with peritonitis; atelectasis	1
Guillain-Barré syndrome with death	1
Atelectasis; stump bronchitis	1
Ipsilateral reactivation	1
Bronchopleural fistula with empyema (nontuberculous)	1
After segmental or local resection (16 patients)	
Bronchopleural fistula without empyema	1
Bronchopleural fistula with empyema	2 (1 tubercular [?]) (1 nontubercular)
Atelectasis	4
Persistent pneumothorax pocket	10
Severe postoperative hemorrhage	1

and were in most cases more seriously ill. Table II lists the complications which occurred in relation to the procedure performed.

A few years ago Overholt and his group[2] introduced the use of the face-down or prone position in thoracic surgery primarily as a method to avoid contralateral spread of disease. Its main advantage, particularly concerning patients with positive secretions, is said to be the drainage of secretions into the trachea and out of the mouth instead of into the contralateral lung. It also is maintained that ventilation of the lungs is better and, consequently, less carbon dioxide is retained than when the patient is in the lateral position. The exponents of the lateral position maintain that the incidence of contralateral spread and similar complications is not any greater, provided adequate clearance of the tracheobronchial tree is maintained during surgical intervention.

In our series of cases complications developed among 29 of 68 patients who were in the prone position when operated on, a complication rate of 41 per cent. Complications developed in 15 of 24 patients who were in the lateral position when operation was performed, or a complication rate of 63 per cent. The one patient who underwent operation in the supine position had a complication postoperatively. The significance of these figures may reasonably be challenged as the operations performed on patients in the lateral position were

performed in the earlier part of our experience and some did not have the benefit of streptomycin and none had the benefit of our increased experience in resective operations. At the time of this report we were using the prone position almost exclusively.

Chemotherapy has afforded a means by which we can produce a gross negativity or at least a reduction in the amount of tracheobronchial secretions and its positivity in a high percentage of cases. The importance of producing such a situation, prior to operation if possible, is demonstrated by contrasting the rate of tuberculous complications of the group of patients who had grossly positive sputum at the time of operation with that of the group whose sputum was negative by concentrate and culture at the time of operation. Of 14 patients with complications due to tuberculosis 10 had positive sputum at the time of operation while 4 had negative sputum by concentrate and culture.

The effect of thoracoplasty performed before, with, or immediately after operation is a difficult point to analyze because of other factors such as extent of disease and recent changes in surgical techniques. Considering only complications due to tuberculosis, we found that 9 of 31 patients, or 29 per cent, who had undergone resections with thoracoplasty had complications, and that 6 of 50 patients, or 12 per cent, who had undergone resections without thoracoplasty had complications. We are of the opinion that these figures misrepresent the value of thoracoplasty in association with surgical measures because most of the patients who had had thoracoplasty and resection followed by complications were patients who underwent operation early in the period covered by our study and were patients with more extensive disease. The recent report of the Veterans Administration[3] shows that 28 per cent of the patients who had lobectomies with chemotherapy but without thoracoplasty had complications, and that only 15 per cent of those who had lobectomies with both thoracoplasty and chemotherapy had complications.

Seven of the 98 patients died within three months after resection. Three had undergone right pneumonectomy. Two of them died as a result of surgical shock and the death of the third was attributed to a bronchopleural fistula with extensive bilateral spread. The left lung of one patient had been removed and this patient also died of surgical shock. A fifth patient had had the upper lobe of the left lung removed. Death in this case was caused by a perforated gastric ulcer with associated peritonitis and atelectasis of the remaining lobes of the lung. The other 2 of these 7 patients had had the upper lobes of their right lungs removed and one of them also had had a segment of the middle lobe removed. Several complications contributed to this latter patient's death including reaction to transfusions, severe subcutaneous emphysema, anoxemia, and intestinal obstruction. Development of the Guillain-Barré syndrome caused the death of the other of these 2 patients.

In addition to these 7 patients who died soon after operation, 3 patients died from eleven months to seven years after resection. All 3 patients had had some cardiac complications. Two had undergone right pneumonectomy; one died ten months after operation of essential hypertension with rupture of the aorta and the other died four years after operation of right cardiac failure. The third patient had undergone segmental resection of the upper lobe of the

right lung. Death in this case occurred seven years postoperatively and was attributed to hypertensive cardiovascular disease.

The postoperative mortality rate is, therefore, 6.4 per cent. Including the three late deaths the total mortality rate of the group is 9.1 per cent.

The importance of the use of chemotherapy and its effect on patients who submit to operations for tuberculosis cannot be overemphasized. The reduction in the number of complications associated with resections performed for tuberculosis is evident in our group of cases and is summarized in Table III.

TABLE III. RELATION OF CHEMOTHERAPY TO COMPLICATIONS AND DEATH OF TUBERCULOUS PATIENTS WHO UNDERWENT RESECTION

OPERATION	NO. OF PATIENTS	PERCENTAGE OF PATIENTS				
		COMPLICATIONS		DEATHS		
		ALL TYPES	TUBERCULOUS TYPE	OWING TO TUBERCULOSIS	OTHER CAUSES	TOTAL
Pneumonectomy						
Before chemotherapy	6	83	50	16	16	32
After chemotherapy	14	50	28	0	14	14
Lobectomy						
Before chemotherapy	2	100	100	0	0	0
After chemotherapy	26	42	19	0	10	10
Segmental resection						
Before chemotherapy	1	100	100	0	0	0
After chemotherapy	60	25	0	0	0	0
Resection (all types)						
Before chemotherapy	10	90	60	10	10	20
After chemotherapy	100	33	10	0	5	5

COMMENT

It has been our experience that the morbidity and mortality rates in cases of tuberculosis in which resective operations have been performed have been greatly reduced since the advent of chemotherapy. In fact, before chemotherapy, resective operations for tuberculosis were dangerous but often necessary in many cases. Our experience, however, with resections prior to the use of chemotherapy was so small that our figures were not representative of the situation. Our experience since chemotherapy, particularly with segmental resection, has been more gratifying and we are of the opinion that our figures compare favorably with those of others. Although 25 per cent of our patients who had segmental resection had complications, it must be remembered that most of the complications noted were of a transient nature and were easily remedied by therapeutic measures.

Little information has been included in the literature concerning the postoperative pneumothoracic space, particularly after resection for tuberculosis. Hence it is interesting to note 10 cases in our series in which the patients had such a space after undergoing segmental resection. The lungs of 8 of the 10 patients re-expanded spontaneously and the space disappeared without further surgical procedure. Aspiration was carried out in several instances, but it was noted that aspiration itself did not produce signficant re-expansion of the lung and disappearance of the space. In the 8 cases in which there was spontaneous

obliteration of the pneumothoracic space, 5 patients had spontaneous obliteration in less than two and one-half months and the remaining 3 had obliteration in less than six months. The other 2 patients had a space of sufficient size that it was felt that a further procedure should be done; accordingly in each a four-rib thoracoplasty was performed which resulted in obliteration of the space. In none of the 10 cases did tuberculous empyema develop. Thus it appears from our own cases that, as a rule, after segmental resection for tuberculosis the remaining portion of the lung will re-expand spontaneously, the space created because of pneumothorax will be obliterated without any significant danger from tuberculous empyema, and obliteration will occur within a few months.

We feel that segmental resection in selected cases is a safe, rational operation. With chemotherapy and modern methods of surgery, anesthesia, and postoperative care, more patients having tuberculosis are being operated on earlier before extensive procedures are necessary, and thereby tissue and function of the lungs are being conserved. Segmental resection is a procedure which adapts itself well to the treatment of tuberculosis.

CONCLUSIONS

Significant statistics on the results of resective operations in treatment of tuberculosis will not be available for several years. Hence, this study is confined to that of the risk of these operative procedures in 110 resections done on 98 patients.

In general, chemotherapy has produced a profound reduction in the risk associated with these operations. Also the less tissue resected, which in most cases means less extensive disease, the lower will be the rate of complications and mortality. The complication rate seems to be lower among those patients operated on in the prone position. The complications due to tuberculosis were much fewer among those patients whose sputum was negative to concentrate and culture prior to operation.

Thoracoplasty done before, with, or immediately after resection did not lower the complication rate appreciably in our series. This is at variance with the experience of most other authors and we feel that perhaps our findings misrepresent the value of thoracoplasty in association with resection.

Our experience with resection prior to chemotherapy was small and disappointing. At the time of this report we are much more encouraged concerning our rates of morbidity and mortality and hope for good results in the future. Further lowering of morbidity and mortality rates may occur with the advent of new chemotherapeutic agents, but this will also depend on earlier operation in selected cases before pulmonary tuberculosis has become extensive and on improved technical ability and experience in caring for the surgical patient.

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COMPARATIVE STUDY OF PULMONARY FUNCTION LOSS: THORACOPLASTY VERSUS SMALL RESECTION IN SURGERY OF TUBERCULOSIS

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THE GRADUAL increase in resective surgery for pulmonary tuberculosis stimulated our interest five years ago to determine the comparative effects of thoracoplasty in contrast to small resections on the loss of pulmonary function in patients surgically treated for tuberculosis. Seventy-one patients were studied with respiratory function tests before and after surgery between January, 1948, and December, 1952, in an effort to further delineate this question.

Posterior staged thoracoplasties were performed on twenty-four of these patients, and forty-seven had small resective surgery of a segmental, subsegmental, or wedge nature. Among the group of thoracoplasty patients, eighteen had their operations as primary forms of surgical therapy, and six of the patients had had phreniclasia performed at least eighteen months prior to their thoracoplasty. All of the thoracoplasties were posterior operations[1] with preservation of relatively long anterior rib segments below the first rib; four patients had five ribs removed, and twenty had six ribs resected.

In the resection group, there were twenty patients who had segmental resection and twenty-seven who had subsegmental or wedge resection. A breakdown of the segmental resection group reveals the following loss of segments: 12 patients—1 segment; 7 patients—2 segments; and 1 patient—3 segments. In the subsegmental and wedge resection group, the number of wedges removed varied from one to twelve: 20 patients had 1 to 3 wedges resected; 6 had 4 to 8; and 1 had 12 wedges resected.

METHOD OF STUDY

The patients studied were men whose ages ranged from 22 to 60 years. Prior to surgery, ventilatory tests included determination of pulmonary volumina, maximum breathing capacity, and walking ventilation; the majority also had bronchospirometry. Function determinations were made within a period of two weeks before surgery. The same studies were repeated postsurgery, the interval being approximately six months for thoracoplasty and three months for resection. A six-month interval was arbitrarily selected for thoracoplasty cases to assure adequate return of function. In resection, trauma and musculoskeletal dysfunction were minimal and recovery was rapid, permitting repetition of tests at the three-month interval. Also, patients undergoing bilateral excisional surgery were considered ready for surgery on the contralateral lung after three months, thereby necessitating study at that

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interval. Testing of patients was conducted by the same personnel, using the same equipment throughout the study.

The patients operated on presented relatively stable tuberculous lesions; a few were more extensive than moderately advanced. In the resected cases, the lesions were usually caseous nodules well controlled by long courses of antimicrobial therapy. Thus, the problem of defects in distribution and diffusion of gases did not seem pertinent. Major considerations were total loss of pulmonary volumina and reduction in the bellows capacity of the lungs, and the volume and oxygen loss of the operated lung.

A Collin respirometer (nine-liter bell, ¾ inch tubing) with soda lime canister removed was employed to measure pulmonary volumina and maximum breathing capacity. Each patient (standing) received three trials and the maximum effort was accepted. Cournand's[2] regression formula was used to calculate predicted maximum breathing capacity. The walking ventilation test was patterned after the method of Warring.[3] The patient walked 360 feet in two minutes, and the exhaled air was collected in a 100-liter Douglas bag. The quantity of gas was measured by passing it through the Collin respirometer and recorded as liters per minute.

Bronchospirometry[4] was performed using a standard Zavod[5] double lumen catheter, introduced with the aid of a laryngeal mirror. Satisfactory laryngotracheobronchial anesthesia was obtained with 1 per cent Pontocaine solution. Preliminary sedation included a barbiturate (sodium luminal, 3 to 4 gr., or sodium amytal, 3 gr.), and Demerol 75 mg., or morphine sulfate ⅙ gr., plus atropine sulfate $\frac{1}{100}$ gr. Correct position of the catheter in the left main bronchus was verified fluoroscopically, the cuff balloons were inflated, and the proximal catheter channels were attached to double recording spirometers containing 100 per cent oxygen and soda lime canisters. Records of oxygen consumption, tidal air, respiratory minute volume, inspiratory and expiratory reserve, and vital capacity were obtained. Bronchoscopy was routinely performed prior to presurgical bronchospirometry.

RESULTS

Tables I, II, and III list individual cases and illustrate loss of pulmonary function with small thoracoplasty, segmental, and wedge resection, respectively. The bronchospirometry figures, listed as percentages, are limited to the operated lung. The purpose of bronchospirometry was to measure loss in oxygen consumption and vital capacity of the operated lung. The figures listed under spirometry and maximum breathing capacity represent total loss of pulmonary function: vital capacity and bellows capacity. The walking ventilation column represents change in walking ventilation (liters) following surgery. The ratio, walking ventilation divided by maximum breathing capacity, is not listed because little change was noted in the majority of cases. In no patient did this ratio approach the critical level, .35, after surgery.

Individual cases in Tables I, II, and III show considerable scattering of functional loss in the various compartments. Many factors beyond control are responsible: extent of surgical procedure, surgical complications, manner of cooperation in rehabilitation program, and intrinsic error in function tests dependent on motivation and volition, for example, maximum breathing capacity. Therefore, results of group analysis may be fairly interpreted as a trend only and not a conclusion.

Some patients (Tables I, II, and III) achieved a greater maximum breathing capacity after surgery: 11—wedge; 6—segmental; and only 3—thoracoplasty. Certainly, this apparent functional improvement should not be attrib-

TABLE I. LOSS OF PULMONARY FUNCTION WITH SMALL THORACOPLASTY

CASE NO.	AGE	SIDE AND RIBS	BRONCHOSPIROMETRY						SPIROMETRY			M.B.C.				W.V. CHANGE L.
			BEFORE O_2%	AFTER O_2%	LOSS O_2%	BEFORE V.C.%	AFTER V.C.%	LOSS V.C.%	BEFORE V.C. (C.C.)	AFTER V.C. (C.C.)	LOSS V.C.%	BEFORE	AFTER	LOSS L.	LOSS %	
1	30	R-5	58	48	10	53	50	3	4450	3320	25	132	150	+18	+14	−1.5
2	55	L-5	55	30	25	39	42	+3	3195	2843	11	89	78	−11	−12	+0.2
3	30	R-5	38	36	2	47	43	4	4067	3964	2	124	102	−22	−18	−2.6
4	59	L-5	—	—	—	—	—	—	3154	2428	23	124	107	−17	−14	−1.5
5	25	R-6	—	—	—	—	—	—	3440	2469	28	82	67	−15	−18	—
6	50	L-6	—	—	—	—	—	—	3112	2697	13	129	99	−30	−23	−3.7
7	38	R-6	—	—	—	—	—	—	4512	3517	22	160	138	−22	−13	−2.2
8	56	R-6	48	35	13	50	39	11	3610	2303	36	75	73	−2	−3	+1.6
9	24	L-6	33	35	+2	42	34	8	4056	2739	32	129	129	0	0	—
10	28	L-6	—	—	—	—	—	—	4710	3433	27	161	158	−3	−2	−1.3
11	29	R-6	51	41	10	46	42	4	4544	3237	29	110	97	−13	−12	+1.1
12	24	R-6	65	47	18	59	43	16	4108	3039	26	103	105	+2	+2	−1.8
13	26	R-6	48	42	6	53	51	2	4980	3745	25	140	124	−16	−12	+1.8
14	34	R-6	62	25	37	67	30	37	4606	3009	35	125	94	−31	−25	−3.4
15	24	R-6	47	45	2	60	44	16	3486	2552	27	121	81	−40	−33	−3.9
16	27	L-6	50	50	0	56	38	18	5498	4710	14	118	124	+6	+5	−1.0
17	41	R-6	—	—	—	—	—	—	3859	2677	31	130	94	−36	−28	+0.9
18	33	R-6	47	38	9	53	46	7	4440	2614	41	125	107	−18	−14	+2.7
19	32	R-6	64	33	31	—	—	—	4814	2988	38	141	131	−10	−7	+5.2
20	27	R-6	60	55	5	—	—	—	3400	2469	27	121	115	−6	−5	—
21	44	R-6	48	47	1	—	—	—	5395	3652	32	149	132	−17	−11	—
22	30	R-6	48	36	12	53	50	3	3569	2541	29	107	94	−13	−12	+0.4
23	56	R-6	37	36	1	39	37	2	2179	1950	10	75	70	−5	−7	—
24	30	L-6	—	—	—	—	—	—	4067	2926	28	118	91	−27	−23	+1.0

TABLE II. LOSS OF PULMONARY FUNCTION WITH SEGMENTAL RESECTION

CASE NO.	AGE	NO. SEGMS.	BRONCHOSPIROMETRY						SPIROMETRY			M.B.C.				W.V. CHANGE L.
			BEFORE O_2%	AFTER O_2%	LOSS O_2%	BEFORE V.C.%	AFTER V.C.%	LOSS V.C.%	BEFORE V.C. (C.C.)	AFTER V.C. (C.C.)	LOSS V.C.%	BEFORE	AFTER	LOSS L.	LOSS %	
1*	38	1	50	47	−3	51	50	1	3963	3859	−3	107	150	+43	+40	−0.8
2*	37	1	50	41	−9	46	43	3	4035	3756	−7	140	161	+21	+15	+3.1
3	57	1+	50	48	−2	48	43	5	2801	2531	−10	105	99	−6	−6	+2.1
4	26	1	50	47	−3	54	43	11	3818	3029	−21	129	124	−5	−4	−0.4
5	29	1	—	—	—	—	—	—	4254	3973	−7	158	163	+5	+3	+3.5
6	30	1+	64	61	−3	57	58	+1	3964	3371	−15	102	102	0	0	−0.1
7	33	2	—	—	—	—	—	—	4648	4088	−12	183	165	−18	−10	−1.7
8	28	1	45	49	+4	51	48	3	4585	4088	−11	134	140	+6	+4	−1.7
9	36	1	44	38	−6	41	36	5	3455	3569	+3	160	153	−7	−4	−0.8
10	28	2	33	37	+4	43	36	7	3444	3320	−4	113	113	0	0	+2.5
11	22	2	49	32	−17	45	35	10	4492	3631	−19	149	142	−7	−5	−0.8
12	60	1+	—	—	—	—	—	—	3382	2511	−26	86	78	−8	−9	+2.3
13	30	1+	50	50	0	52	49	3	3725	3320	−11	69	61	−8	−9	−0.2
14	33	1	49	50	+1	48	39	9	4482	3403	−24	137	125	−12	−9	−1.3
15	57	2+	52	50	−2	57	54	3	2531	2594	+2	99	101	+2	+2	+0.2
16	58	2	—	—	—	—	—	—	4254	3776	−11	99	102	+3	+3	−1.7
17	33	3	—	—	—	—	—	—	3465	3278	−5	111	99	−12	−12	−1.3
18	41	2	47	45	−2	51	46	5	5650	5125	−9	162	145	−17	−10	—
19	30	1+	58	55	−3	57	57	—	3920	3420	−13	150	129	−21	−14	−1.6
20	55	2	49	51	+2	53	50	3	3963	3392	−14	125	104	−21	−17	−2.1

*Post surgical M.B.C. increased 10 per cent or more.

TABLE III. LOSS OF PULMONARY FUNCTION WITH SUBSEGMENTAL AND WEDGE RESECTION

CASE NO.	AGE	NO. WEDGES	BRONCHOSPIROMETRY						SPIROMETRY			M.B.C.				W.V. CHANGE L.
			BEFORE O_2%	AFTER O_2%	LOSS O_2%	BEFORE V.C.%	AFTER V.C.%	LOSS V.C.%	BEFORE V.C. (C.C.)	AFTER V.C. (C.C.)	LOSS V.C.%	BEFORE	AFTER	LOSS L.	LOSS %	
1	57	1	51	48	−3	56	50	6	2915	2739	6	83	81	−2	−2	+2.2
2	40	1	45	47	+2	45	41	4	4948	4731	4	129	129	0	0	−0.5
3	40	2	53	51	−2	59	54	5	4731	4606	3	129	124	−5	−4	0
4	32	1	55	43	−12	53	42	11	4482	3590	20	122	130	+8	+6	+3.2
5	28	2	50	51	+1	—	—	—	4150	3942	5	132	134	+2	+1	+1.0
6	50	3	48	51	+3	50	42	8	5268	4627	12	167	137	−30	−18	−2.0
7	38	3	—	—	—	—	—	—	4046	4046	0	124	102	−22	−18	+0.9
8	24	8	44	38	−6	50	43	7	5187	4959	4	156	148	−8	−6	+0.7
9	30	8	54	53	−1	58	54	4	4191	3652	13	105	110	+5	+5	0
10	24	3	48	47	−1	46	46	0	3558	3590	+1	142	150	+8	+6	+1.8
11	24	5	50	41	−9	51	38	13	5146	3922	24	198	182	−16	−8	+1.7
12*	32	1	49	38	−9	51	43	8	4896	4357	11	118	142	+24	+20	0
13	58	1	52	50	−2	52	49	3	3880	3735	4	81	81	0	0	0
14	34	12	37	32	−5	33	29	4	3569	2520	29	110	94	−16	−14	—
15	29	2	46	43	−3	47	42	5	5125	4772	7	172	166	−6	−3	−2.1
16	57	2	56	48	−8	62	51	9	3485	3361	3	—	—	—	—	−2.6
17*	29	2	41	29	−12	40	29	11	4233	3859	9	115	134	+19	+16	−1.7
18	40	3	56	56	0	58	59	+1	5084	4648	4	162	174	+12	+7	−2.2
19	28	3	63	56	−7	64	56	8	3320	3195	4	113	113	0	0	−0.5
20	28	3	—	—	—	—	—	—	4337	4088	8	161	148	−13	−8	+0.5
21*	23	4	—	—	—	—	—	—	5001	4886	2	164	183	+19	+11	+1.5
22	31	3	44	32	−12	40	27	13	3569	3029	15	156	145	−11	−7	−2.6
23	31	7	48	48	0	38	36	2	4274	4191	2	156	161	+5	+3	+1.2
24	40	1	47	44	−3	46	42	4	4046	4171	3	111	114	+3	+2	−2.4
25	28	3	47	44	−3	46	37	9	3652	3258	11	110	98	−12	−11	−0.8
26*	28	2	46	38	−8	45	41	4	4980	4399	12	188	212	+24	+12.7	—
27	27	5	51	49	−2	53	49	4	4005	3682	8	137	118	−19	−14	—

*Postsurgical M.B.C. increased 10 per cent or more.

uted to the surgery per se because actually it represents no measurable loss in function. In a laboratory test, dependent upon complete patient cooperation and maximum effort, some patients in spite of reassurance are reluctant to extend themselves to the limit, particularly before surgery. After surgery there are the advantages: (1) experience gained by repetition, (2) improvement in physical status secondary to rehabilitation exercises, and (3) the mental lift of being on the road to recovery. Thus, those patients least affected by surgery, those undergoing small resection, are most likely to show an increase in maximum breathing capacity after surgery. Six resection patients, two segmental and four wedges (Tables II and III), when tested postoperatively exceeded their pre-resection M.B.C. by 10 per cent or more (+11 to +40 L.). These figures were excluded in determining the mean M.B.C. (Table IV), because it is believed the unusual gains represent failure to obtain maximum patient cooperation prior to surgery. To include such abnormal pains in M.B.C. in a small series would create an erroneous impression of no function loss. Of the patients who lost function after resection, contributing factors may be: lung leak with delayed expansion, infection, excessive pleural reaction, and hemothorax with adherent diaphragm. An analysis of individual cases to determine cause of function loss was not undertaken.

TABLE IV. SPIROMETRY: LOSS OF PULMONARY FUNCTION

OPERATION		5- OR 6-RIB THORACOPLASTY	SEGMENTAL RESECTION	WEDGE RESECTION
CASES	(All men)	24	20	27
AGE	Mean age	35.5	38.0	34.4
	Extremes of age	24-59	22-60	23-58
VITAL CAPACITY (C.C.)	Before (mean)	4052	4299	3941
	After (mean)	2992	3992	3501
	Loss (mean)	1059	440	353
	Range of loss	−103 to −1743	+114 to −1079	+125 to −1224
	Per cent loss (mean)	25.4	11.1	8.2
M.B.C. (L.)	Before (mean)	120.0	126.1	134.2
	After (mean)	106.6	119.1	129.0
	Loss (mean)	13.5	7.0	5.3
	Range of loss	+6 to −40	+6 to −21	+12 to −30
	Per cent loss (mean)	11.3	5.5	3.9
W.V. (L.)	Change (L.) after surgery	−3.9 to +5.2	−2.1 to +3.5	−2.6 to +3.2

Table IV analyzes age, and changes in spirometry (vital capacity), maximum breathing capacity, and walking ventilation before and after surgery. The mean age of the patients studied is noted to agree closely in the three groups. The mean loss in vital capacity is: Thoracoplasty—1,059 c.c., 25.4 per cent; Segmental—440 c.c., 11.1 per cent; and Subsegmental or wedge—353 c.c., 8.2 per cent. Loss in maximum breathing capacity following surgery: Thoracoplasty—13.5 L., 11.3 per cent; Segmental—7 L., 5.5 per cent; and Subsegmental or wedge—5.3 L., 3.9 per cent. A rough correlation of function loss is apparent in the three groups. Loss of function in thoracoplasty (vital capacity and maximum breathing capacity) is grossly twice that of segmental, and three times that of subsegmental or wedge resection. The greatest variations in

walking ventilation following surgery were +5.2 L. and –3.9 L. The great majority of patients approximated the presurgical test figure within 3 L. No definite postsurgical trend toward decrease or increase of walking ventilation was noted.

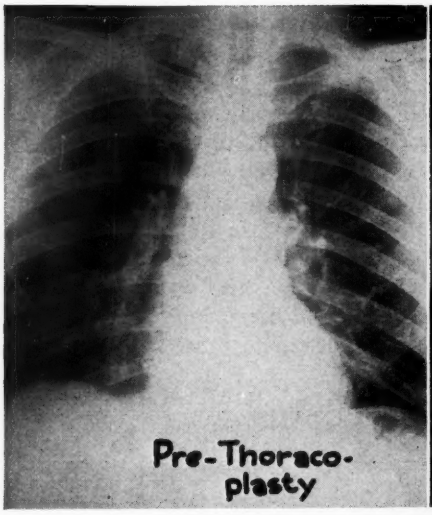

Fig. 1.

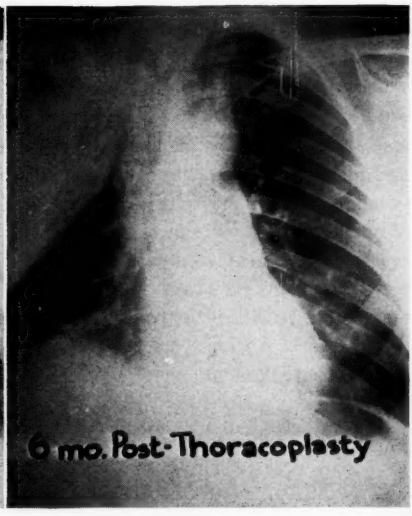

Fig. 2.

Fig. 1.—(Case History I.) This 34-year-old white man was admitted August, 1950, with moderately advanced tuberculosis; the right apex contained a 2 cm. cavity. Pulmonary function prethoracoplasty was normal.

Fig. 2.—(Case History I.) Two-stage six-rib thoracoplasty was performed in November and December, 1950, complicated by pleural tear and effusion. X-ray view taken six months after surgery reveals moderate scoliosis. Diaphragm adherent laterally with limited motion. Pulmonary function diminished significantly.

Table V is a composite of the patients having bronchospirometry before and after surgery; it illustrates loss of oxygen consumption and vital capacity for the operated lung, expressed as mean percentages. Oxygen consumption diminished as follows: Thoracoplasty—10.6 per cent; wedge—4.4 per cent; segmental—2.6 per cent. Vital capacity of the operated lung was reduced: Thoracoplasty—9.2 per cent; wedge—6.2 per cent; and segmental—4.4 per cent. A significantly greater functional loss occurs in thoracoplasty where total vital capacity is diminished 25.4 per cent and vital capacity of the operated lung only 9.2 per cent, indicating that musculoskeletal dysfunction produced by thoracoplasty restricts movement of the entire thorax.

INDIVIDUAL CASE STUDIES

Four case histories, two thoracoplasty and two resection, are briefly presented with x-ray pictures to illustrate that pulmonary function loss may vary widely. Complications may contribute significantly to function loss.

TABLE V. BRONCHOSPIROMETRY*

SURGERY	BR. SPIR.	PRE-SURG. O_2 %	P.O. O_2 %	O_2 LOSS %	PRE-SURG. V.C.%	P.O. V.C.%	% LOSS V.C.
Small thoracoplasty	17	50.5	39.9	10.6	51.2	42.0	9.2
Wedges	24	49.2	44.8	4.4	49.6	43.4	6.2
Segmental	15	49.3	46.7	2.6	50.2	45.8	4.4

*Measurements are for operated side (percentages listed are the mean).

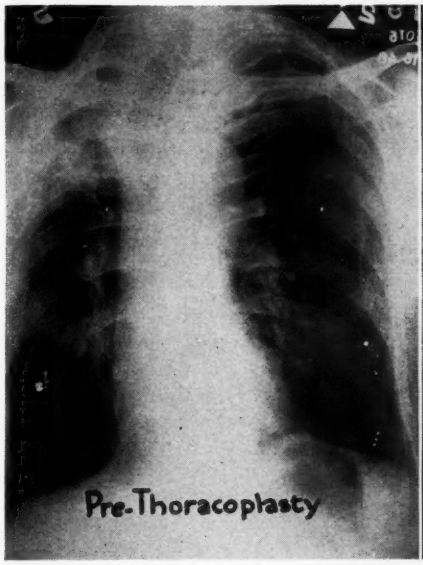

Fig. 3.

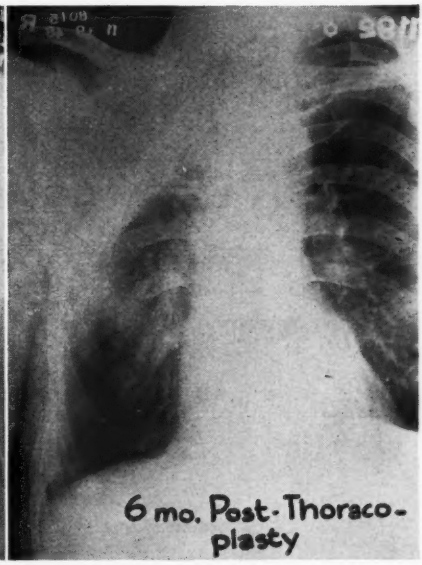

Fig. 4.

Fig. 3.—(Case History II.) A 56-year-old white man was admitted September, 1947, with far-advanced, chronic, fibrocavitary tuberculosis of the right upper lobe. Presurgical pulmonary function was fair.

Fig. 4.—(Case History II.) Six-rib thoracoplasty was performed in four stages (March through May, 1948). X-ray picture six months following surgery shows selective collapse with cavity closure. Minimal drop in pulmonary function.

CASE HISTORY I.—(Table I. Thoracoplasty. Case 14.) G. H., a well-developed, muscular, white man, 34 years old, showed considerable loss of function following a six-rib, two-stage, right thoracoplasty (Figs. 1 and 2). A pleural tear during the second stage precipitated an effusion which cleared slowly, leaving an adherent sluggish diaphragm. In addition, despite rehabilitating exercises, he developed considerable cervical-dorsal scoliosis. The following loss of pulmonary function occurred: Bronchospirometry (figures for operated side): Oxygen loss—37 per cent; Vital capacity diminished—37 per cent; Spirometry: Loss of vital capacity—35 per cent; Loss of maximum breathing capacity—25 per cent. Walking ventilation after surgery dropped 3.4 L.

CASE HISTORY II.—(Table I. Thoracoplasty. Case 23.) L. L., 56 years old, underwent a two-stage, right thoracoplasty, six ribs, and lost little function (Figs. 3 and 4). This patient already had a rigid poker spine, secondary to rheumatoid spondylitis. A well-tailored thoracoplasty, limiting collapse to chronic fibrocavitary disease at the right apex, produced

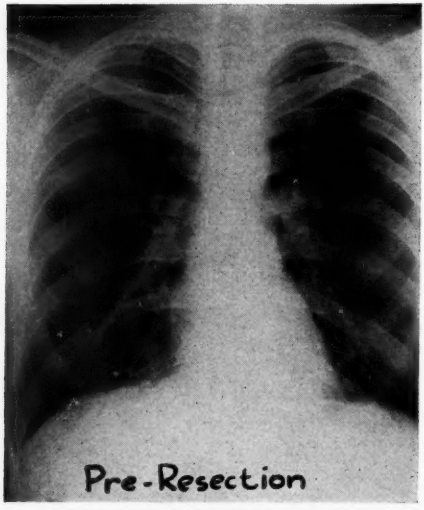

Fig. 5.

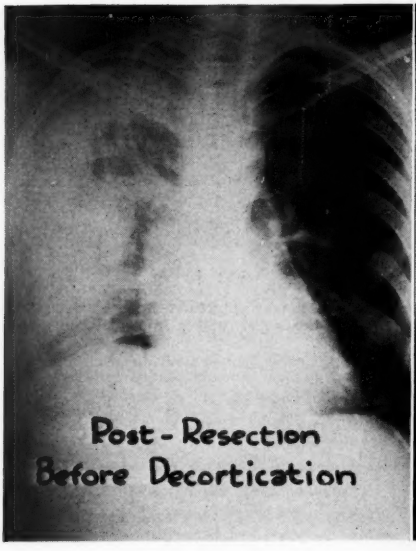

Fig. 6.

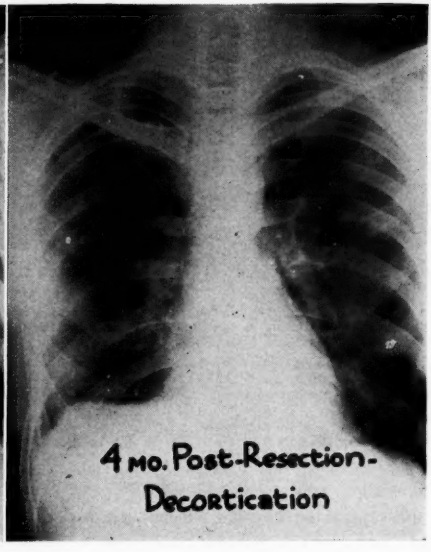

Fig. 7.

Fig. 5.—(Case History III.) A 24-year-old white man was admitted in 1952 with moderately advanced pulmonary tuberculosis of the right upper lobe. He was treated for four months prior to resection with daily streptomycin and PAS (retreatment). X-ray stability has occurred with no open cavity. Presurgical pulmonary function was excellent.

Fig. 6.—(Case History III.) X-ray view taken eleven days after resection. Five wedges (caseous tuberculosis) resected from right upper lobe on April 10, 1952. Hemothorax followed; the patient's condition not improved by Varidase and aspiration. Decortication twelfth postoperative day with bronchial leak and slow re-expansion of right lung.

Fig. 7.—(Case History III.) Four months after wedge resection and decortication. Motion of right diaphragm impaired slightly. Significant function loss prevented by decortication.

little change in function. Loss of function: Bronchospirometry (figures for operated side): Oxygen loss—1 per cent; Vital capacity diminished—2 per cent; Spirometry: Loss of vital capacity—10 per cent; Loss of maximum breathing capacity—7 per cent.

CASE HISTORY III.—(Table III. Wedge. Case 11.) F. K. (Figs. 5, 6, and 7), aged 24 years, had excellent function prior to removal of caseous nodules, five wedges, from the right upper lobe (Figs. 5, 6, and 7). Following surgery, hemothorax occurred, requiring decortication twelve days after resection. Subsequent expansion of the right lung was slow due to bronchial leak, and disruption of the wound occurred. Pulmonary function tests were delayed until four months after surgery because of the complications. The operated lung showed a 9 per cent drop in oxygen consumption and 13 per cent loss in vital capacity. Spirometry showed vital capacity reduced 24 per cent and maximum breathing capacity surprisingly diminished only 16 L., 8 per cent. Postresection decortications, no doubt, prevented a more serious loss of function.

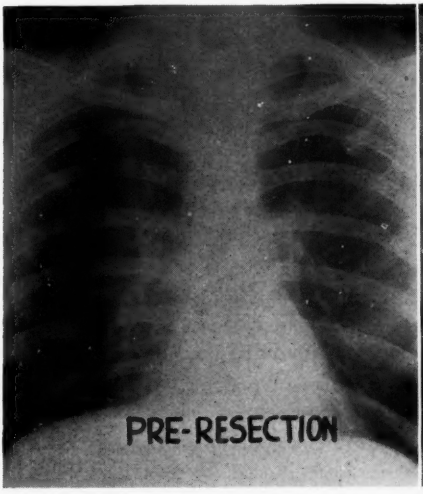

Fig. 8.

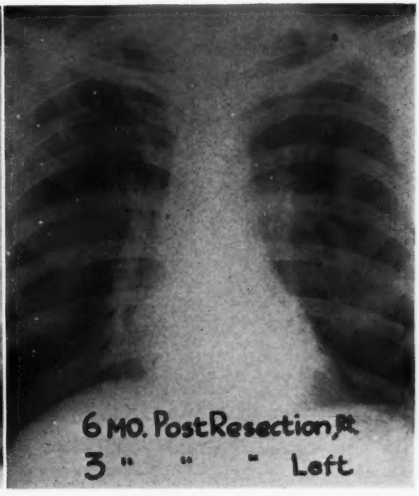

Fig. 9.

Fig. 8.—(Case History IV.) A 40-year-old white man was admitted in 1951 with moderately advanced, bilateral pulmonary tuberculosis. Residual caseous nodules both upper lobes after six months combined streptomycin and PAS therapy.

Fig. 9.—(Case History IV.) Bilateral small resection completed. Two wedges removed from right upper lobe Sept. 20, 1951; one wedge resected from left upper lobe Dec. 4, 1951. X-ray film three months following last stage shows minimal postresection changes in upper lung fields. Minimal loss of pulmonary function.

CASE HISTORY IV.—(Table III. Wedge. Cases 2 and 3.) A. S. was a 40-year-old white man who had bilateral resection (Figs. 8 and 9). Two wedges were removed from the right upper lobe, and three months later a single wedge was resected from the left upper lobe. Pulmonary re-expansion was prompt and no complications occurred. Loss of pulmonary function, following bilateral surgery, was negligible. Total loss of vital capacity—7 per cent. Total loss of maximum breathing capacity—4 per cent: Bronchospirometry (figures for operated lung): Following surgery on the right, oxygen consumption dropped 2 per cent; Vital capacity decreased 5 per cent. After surgery on the left, oxygen consumption increased 2 per cent; Vital capacity decreased 4 per cent.

DISCUSSION

The effect of thoracoplasty on pulmonary function has been adequately studied, but little has been published regarding functional alteration with small resection. Kaltreider[6] commented that thoracoplasty produces a greater reduction in the vital capacity than is to be expected from the extent of lung tissue compressed. He noted a 50 per cent reduction in the predicted normal value of vital capacity (based on height) in individuals with only five-, six-, or seven-rib thoracoplasty, and as an explanation he stated that thoracoplasty interferes with the mechanics of respiration by reducing the lateral expansion of the chest, excursion of the diaphragm and rib rotation.

Leiner[7] noted that following thoracoplasty, total pulmonary volume is diminished, reserve air showing the greatest reduction. In nine six-rib thoracoplasties he noted an average maximum breathing capacity loss of 14 per cent and an average vital capacity loss of 24 per cent. After a six-rib thoracoplasty, the oxygen intake showed a tendency to decrease and the vital capacity decreased in all cases on the thoracoplasty side. Warring[3] studied twenty-six thoracoplasties (majority eight ribs or more) and noted lowering of the maximum breathing capacity in twenty-five cases, in a few as much as 30 to 40 L. In only five patients did walking ventilation change 5 L. or more following thoracoplasty.

Cournand and Richards[8] noted no consistent correlation between the number of ribs resected and the decrease in maximum breathing capacity. Important factors disturbing such a correlation in individual cases were the development of scoliosis, further disturbance in diaphragmatic function or collapse of variable amounts of normal lung tissue. Gaubatz, cited by Cournand,[8] studied 200 cases and concluded that an apical thoracoplasty decreases maximum breathing capacity up to 15 per cent of its preoperative value.

At variance with these opinions, Wright and Woodruff,[9] on the basis of twenty-five thoracoplasties, concluded that when collapse is confined to diseased lung tissue, no significant reduction in respiratory capacity on the surgical side occurs. They stated that after sufficient time had elapsed for return of mobility and comfort, the maximum breathing capacity increased, often by as much as 50 per cent, this increment being due to strengthening of respiratory muscles in an exercising patient as compared to his former status as a bed patient. It was their opinion that compressing healthy lung tissue reduced breathing reserve, but that this was compensated for by an increase in respiratory muscle power on return to health and exercise.

In a series of segmental resections, Kelley and Pecora[10] reported definite improvement in ventilatory function (maximum breathing capacity) postoperatively when two, three, or four segments were resected, with a drop below the preoperative level when more than four segments were removed. Our study does not support this finding. To assume that the improved function is a direct result of segmental resection ignores pertinent factors such as improvement in respiratory status with rehabilitation exercise, experience gained by repetition of a laboratory test, and improved patient morale. Overholt and associates[11] performed pulmonary function tests postoperatively in patients undergoing

segmental resection for bronchiectasis. A correlation was noted in that the maximum breathing capacity tended to approach the predicted normal level in proportion to the number of healthy segments conserved with minimum postoperative respiratory complications.

In the present series of five- and six-rib thoracoplasty, oxygen consumption and vital capacity of the collapsed lung were diminished, 10.6 per cent and 9.2 per cent, respectively. Total vital capacity was reduced 25.4 per cent, maximum breathing capacity reduced 11.3 per cent. A significant reduction in total vital capacity and maximum breathing capacity occurred in the majority of cases. Loss of oxygen consumption and vital capacity for the operated lung occurred in almost all cases, but varied considerably in extent. Walking ventilation showed no trend to increase or decrease after surgery, extremes being –3.9 L. and +5.2 L.

The advantage of limited resection over small thoracoplasty in preservation of pulmonary function is illustrated in Tables IV and V. Total vital capacity loss (mean) with thoracoplasty, segmental, and wedge resection (Table IV) is 25.4 per cent, 11.1 per cent, and 8.2 per cent, respectively; maximum breathing capacity loss: 11.3 per cent, 5.5 per cent, and 3.9 per cent, respectively. Table V (bronchospirometry) again shows an advantage, though not as pronounced, of small resection over thoracoplasty. Analysis of Tables II and III reveals no consistent correlation between number of wedges or segments removed and the degree of pulmonary function loss.

SUMMARY

Seventy-one patients were studied comprising three groups: Five- and six-rib thoracoplasty, segmental, subsegmental, and wedge resection. Pulmonary function tests performed before and after surgery included: bronchospirometry to evaluate the effect on the operated lung; vital capacity, maximum breathing capacity, and walking ventilation to determine the alteration in total lung function. Individual cases revealed varying degrees of functional loss, the most consistent and significant loss occurring in the thoracoplasty group. A limited series such as this, involving many variables, does not lend itself to statistical analysis. However, a trend is apparent, namely, that loss of functional (vital capacity and maximum breathing capacity) with segmental and wedge resection is less than with thoracoplasty. In this study, the functional loss with segmental resection is grossly one-half and with subsegmental or wedge resection one-third that loss seen after small thoracoplasty.

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A COMPARISON OF THORACOPLASTY AND RESECTION THERAPY IN PULMONARY TUBERCULOSIS

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UNTIL recently, the ravages of tuberculosis upon the lung had not been amenable to surgical excision. Although the principle of excision of foci of tuberculosis had been well established in other organs, such as the kidney and bone, the tendency of pulmonary tuberculosis to spread following surgical excision effectively prevented the application of the same principle to the lung. Instead, phthisiologists relied upon pneumothorax, phrenic crush, pneumoperitoneum, and ultimate extrapleural thoracoplasty to collapse tuberculous cavities and allow them to heal by fibrosis and calcification.

The advent of effective bacteriostatic agents, beginning with streptomycin in 1947, has led to new concepts in the treatment of pulmonary tuberculosis.[1-3] Not only do the antibiotics provide the phthisiologist with a more effective means of arresting the disease, but they also enable the surgeon to invade the lungs and remove residual foci of infection.

During the last five years, the principle of excising residual pulmonary foci, after the disease has been rendered chronic by antibiotics and other antituberculous measures, has expanded rapidly. Some thoracic surgeons have not limited themselves to using pulmonary excision for the generally accepted indications. They have applied excisional therapy to smaller noncavitary foci which might be potential sources of reactivation or reinfection.[4, 5] Other thoracic surgeons, mindful of the effectiveness and safety of extrapleural thoracoplasty, have chosen to retain the latter procedure and to utilize pulmonary excision only where thoracoplasty was known to fail.[6-8]

The present study was undertaken in order to compare cases taken from the same hospital population and treated with either thoracoplasty or pulmonary resection. It seemed that not only would such a study have historical interest, but also it would provide a means of comparing the two methods—thoracoplasty and pulmonary excision—on the basis of operative results and postoperative mortality and morbidity. Furthermore, with the aid of statistical analysis, some insight could be obtained into the factors responsible for the recently improved lot of patients with pulmonary tuberculosis.

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MATERIAL AND METHODS

This study included 474 major procedures done by the combined surgical services of the Charity Hospital from Jan. 1, 1942, through Dec. 31, 1951. There were 321 staged extrapleural thoracoplasties, eighty-one lobectomies (including five segmental resections), and seventy-two pneumonectomies. Forty-three (53 per cent) of the lobectomies and thirty-six (50 per cent) of the pneumonectomies had concomitant thoracoplasties which were not included in the thoracoplasty group. Sixty-four (79 per cent) of the lobectomies were done on the upper lobes and seven (9 per cent) were done on the lower lobes. Ten (12 per cent) were right middle lobe lobectomies combined with upper or lower lobe excisions.

There were 244 male patients and 230 female patients. Three hundred seven patients were white and 167 were nonwhite. The highest incidence of operative cases was in the third to the fifth decades. A few resections were applied in the first decade of life, the youngest patient being 3 years old. Two thoracoplasties were done in patients over 60 years of age, the oldest being 66 years.

The majority of the cases had collapse therapy prior to major surgery. Two hundred and sixty-seven had pneumothorax, sixty had pneumoperitoneum, and twenty-three had both. The average duration of symptoms before thoracoplasty and before resection was the same—about two years.

Most of the surgical procedures were applied to extensive tuberculosis. Sixty-four per cent of the total series had far-advanced disease* and 35 per cent had moderately advanced disease. Only five patients (1 per cent) had minimal disease. Sixty per cent of the cases were bilateral and 86 per cent were cavitary.

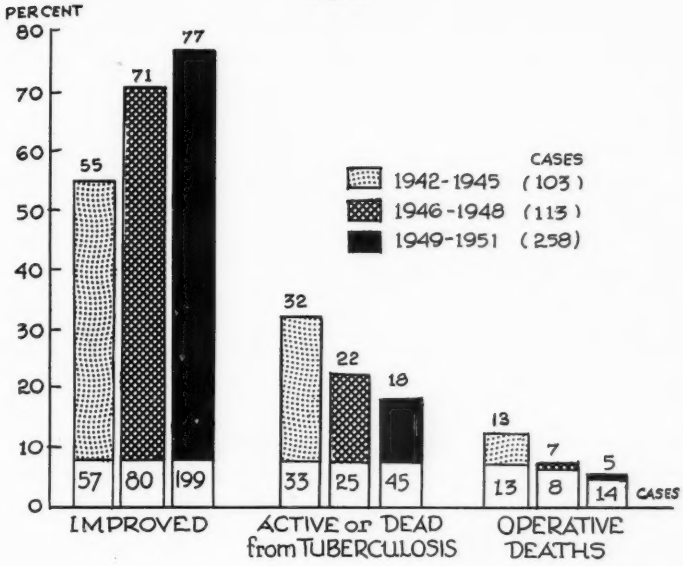
It should be pointed out that the long-range follow-up of our series could not be fully accomplished. Three hundred twenty patients were studied by roentgenograms and enough sputum studies to satisfy the N. T. A. classification of "active," "inactive," or "arrested." One hundred nineteen patients (27 per cent) had to be classified in a "probably arrested" group, because of limited sputum cultures or inability to obtain return visit of the patient. However, 67 per cent of the probably arrested group had been followed by roentgenograms and partial sputum studies by their clinicians for one to ten years and were considered by them to be arrested or inactive. The remainder of these cases were primarily patients done in the early years of this series who had been inactive or arrested at the last clinic visit and who could not be traced at the time of this study. The limitations of follow-up were equally distributed among the various procedures being studied and did not seem to alter significantly their comparison (Table I).

RESULTS OF SURGICAL THERAPY

Thirty-five patients died immediately after surgery, a case fatality rate of 7.4 per cent. There were 103 additional failures (21.8 per cent) and 336

*The National Tuberculosis Association Classification of 1950 is used throughout this report.

Fig. 1.



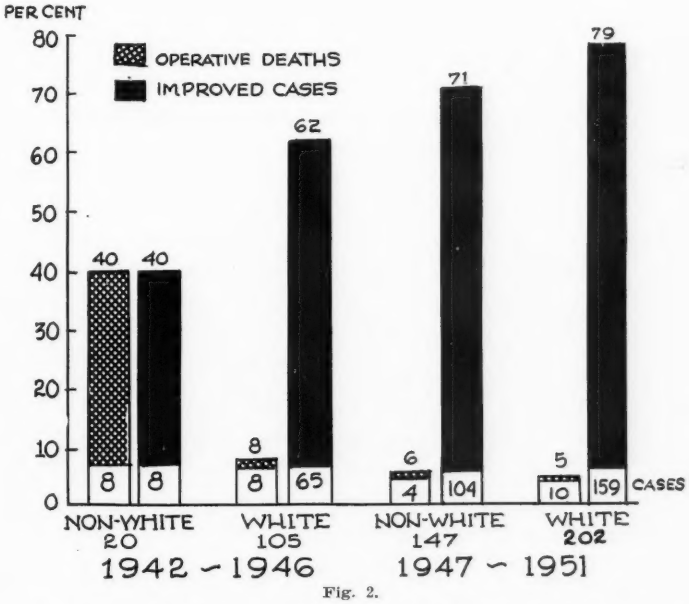


Fig. 2.

Fig. 1.—Comparison of surgical results by period of time.
Fig. 2.—Racial differences in operative mortality and salvage rates by period of time.

improved cases (70.8 per cent) postoperatively. The failures included all immediate postoperative deaths, all late deaths from tuberculosis and all living patients in which the tuberculosis remained active. The improved cases included all those classified as "inactive," "arrested," or "probably arrested" (Table I).

TABLE I. RESULTS IN 474 SURGICAL PROCEDURES

	THORACOPLASTIES	LOBECTOMIES	PNEUMONECTOMIES	TOTALS
Improved cases	224	64	48	336
Inactive	43	3	5	51
Arrested	110	35	21	166
Probably arrested	71	26	22	119
Unimproved cases	97	17	24	138
Continued activity	43	6	10	59
Delayed deaths	30	8	6	44
Operative deaths	24	3	8	35
Total cases	321	81	72	474

The entire series showed a steady improvement in results with the passage of time (Fig. 1). The total improved cases, that is, the salvage rate, rose from 55 per cent in the period 1942 to 1945 to 77 per cent in the period 1949 to 1951. The operative case fatality rate fell from 13 per cent to 5 per cent.

Improvement was most marked in the nonwhite patients, particularly since 1947 (Fig. 2). Before 1947, the nonwhite operative mortality rate was 40 per cent and the salvage rate was 40 per cent. Since then the mortality rate has fallen to 6 per cent and the salvage rate has risen to 71 per cent. With improved results, the application of surgery to nonwhite patients has increased (Fig. 3).

In the last five years, a marked increase in the annual number of operations has occurred. Before 1947, twenty to thirty cases were done per year. Since 1947, the number has increased steadily to the present annual rate of eighty or more (Fig. 4).

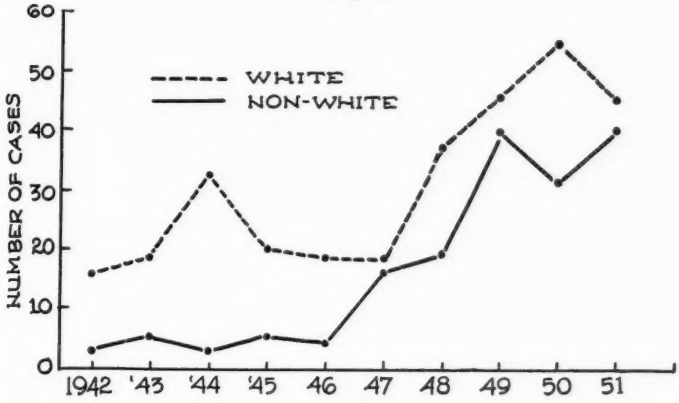
Until recently, staged extrapleural thoracoplasty of the selective (Alexander) type has been the treatment of preference when a major surgical procedure was indicated. Resections were performed only when thoracoplasty had failed or could not be reasonably expected to succeed. Since 1947, the number of resections has rapidly increased and, in the past two years, more resections than thoracoplasties have been performed (Fig. 4). It is apparent that resection is now frequently elected in patients who are suitable candidates for thoracoplasty. "Elective" resections in the total series comprise 82 per cent of the lobectomies and 38 per cent of the pneumonectomies (Table II). In the last two years, twenty of the extrapleural thoracoplasties were of the one-stage Paulino type, which has been described elsewhere.[10]

FACTORS INFLUENCING SURGICAL RESULTS

To determine the factors which might have specifically affected the mortality and salvage rates, the series was studied with regard to race, sex, age, use of streptomycin, extent of disease, period of time, and type of operative risk

the patient presented. The three factors which significantly influenced the surgical results were the *race,* the *"operative risk"* of the patient and the *period of time* during which the procedure was done.

Fig. 3.



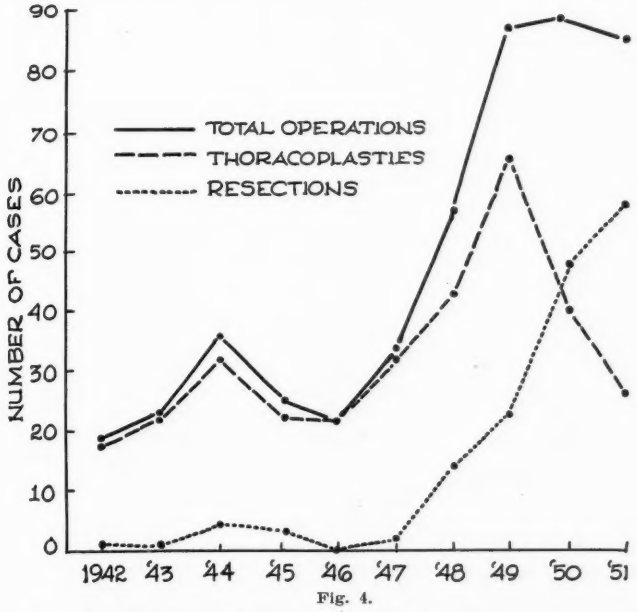


Fig. 4.

Fig. 3.—Annual incidence of surgical procedures by race.
Fig. 4.—Annual incidence of total procedures, thoracoplasties, and resections.

Race.—The white patients had an operative case fatality rate of 5.88 per cent, while the nonwhite patients had an operative case fatality rate of 10.2 per cent. The difference between these rates was statistically significant, the probability of chance difference being 4 per cent.

TABLE II. INDICATIONS FOR RESECTION THERAPY

INDICATIONS	LOBECTOMIES		PNEUMONECTOMIES	
	CASES	PER CENT	CASES	PER CENT
Elective resection	66	81.5	27	37.5
Destroyed lung	–	–	18	25.0
Thoracoplasty failure	5	6.2	10	13.9
Empyema	–	–	8	11.0
Possible neoplasm	3	3.7	2	2.8
Endobronchial stenosis	1	1.2	2	2.8
Bronchiectasis	1	1.2	2	2.8
Tension cavities	2	2.5	1	1.4
Lower lobe disease	3	3.7	–	–
Resection failure	–	–	2	2.8
Totals	81	100.0	72	100.0

Operative Risk.—Determination of the operative risk of the patients included an evaluation of their over-all medical status as well as the extent of their tuberculosis. All the cases, regardless of the procedure done, were divided into good, fair, and poor-risk groups and the mortality and salvage rates of the groups were compared. As expected, the good operative risks had the best surgical results (Fig. 5). These differences were also statistically significant, the probability of chance difference being about 1 per cent.

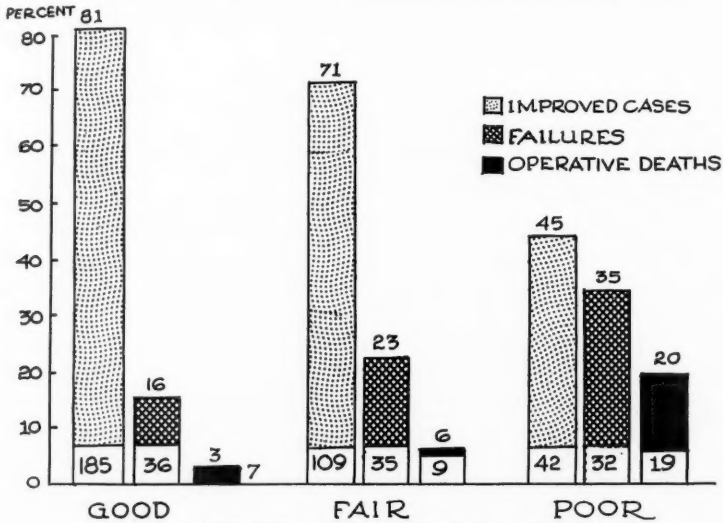


Fig. 5.—Comparison of surgical results by operative risk.

Period of Time.—Since 1947, the use of streptomycin, adequate transfusions, establishment of postoperative recovery rooms, creation of a separate thoracic service, and better selection of patients have acted to safeguard the tuberculous patient undergoing major thoracic surgery. Therefore, as previously noted, the best results were obtained during the latter years of the series (Fig. 1). These time differences were statistically significant, the probability of chance being 2 per cent.

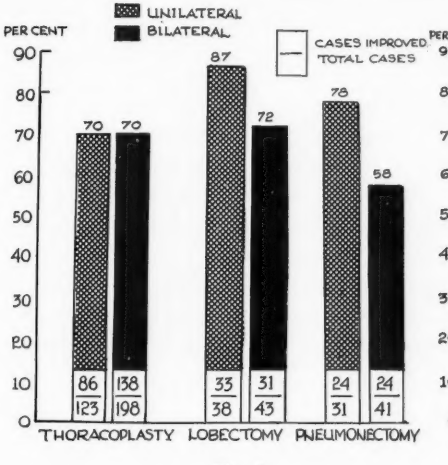


Fig. 6.

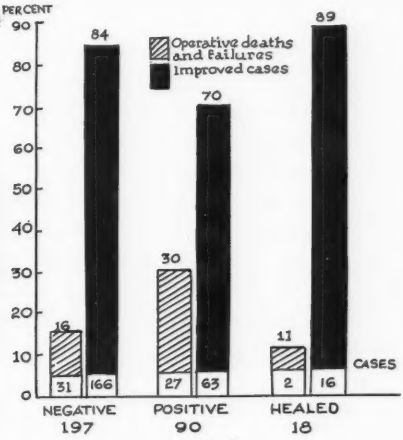


Fig. 7.

Fig. 6.—Influence of extent of pulmonary disease on surgical results.

Fig. 7.—Influence of bronchial disease on surgical therapy. Comparison of preoperative bronchoscopic findings with postoperative results.

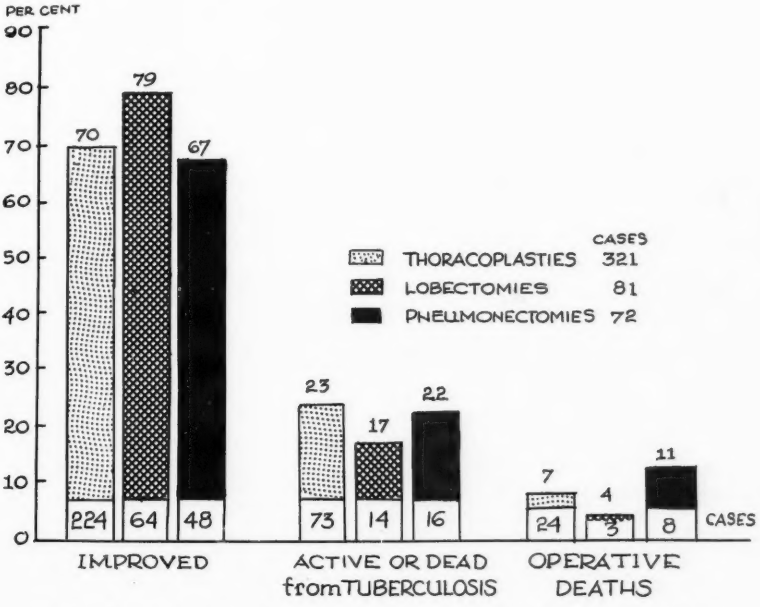


Fig. 8.—Comparison of crude mortality and salvage rates by surgical procedure.

Three incidental findings of interest also were noted:

1. Whether the tuberculous process was unilateral or bilateral exerted a considerable influence on the salvage rates of the resections (Fig. 6). It did not, however, influence the final results in the thoracoplasties and did not significantly affect the operative case fatality rate of any of the procedures.

2. The N. T. A. classification of the extent of pulmonary disease was a fair index for predicting the surgical result. As would be expected, the far-advanced cases had a lower salvage rate and a higher mortality rate than the moderately advanced or minimal cases.

3. The surgical result was closely correlated with the bronchoscopic findings just before surgery. Those cases with no endobronchial disease or with healed endobronchial disease did well. Those with active endobronchial disease did poorly (Fig. 7).

COMPARISON OF SURGICAL RESULTS BY PROCEDURE

The crude mortality and salvage rates of each of the procedures are shown in Fig. 8. The best results were obtained with the lobectomies; the poorest with the pneumonectomies. The salvage rate for lobectomy was 79 per cent as compared with 70 per cent for thoracoplasty and 67 per cent for pneumonectomy. The operative mortality rate for lobectomy was 4 per cent as compared with 7 per cent for thoracoplasty and 11 per cent for pneumonectomy. These differences, however, are not statistically significant, for the probability that they are due to chance is 22 per cent.

About one-half of the thoracoplasties were done before 1947 and did not have the benefit of streptomycin and improved patient management. The majority of the resections were done after 1947 and did have these advantages. In addition, the lobectomy series was heavily weighted with good-risk patients having moderately advanced or minimal disease. The thoracoplasty and pneumonectomy series had a large number of poor-risk patients with far-advanced disease (Figs. 9 and 10).

Adjustment of the crude results for these group differences had an equalizing influence. The differences in the adjusted mortality and salvage rates were even less than in the crude form (Fig. 11). On the basis of operative results, no procedure was found to be superior to the others.

COMPLICATIONS

Three major types of complications occurred: (a) immediate postoperative deaths, (b) delayed postoperative deaths from tuberculosis, and (c) continued postoperative tuberculous activity.

As shown in Table III, the number of immediate postoperative deaths for thoracoplasties and resections was almost the same (7.5 per cent and 7.4 per cent, respectively). The most common causes of death in both procedures were pulmonary in type, and comprised approximately three-fourths of the immediate deaths in the thoracoplasty series and one-half of the immediate deaths in the resection series. Cardiovascular and renal complications caused

the remainder of the immediate deaths. The over-all case fatality rate in both procedures was so similar that it was impossible to use this as a criterion for choosing one procedure in preference to the other.

The same conclusion followed an analysis of the causes of delayed postoperative deaths and of continued postoperative tuberculous activity. The chief cause of delayed death and of continued activity following either

Fig. 9.

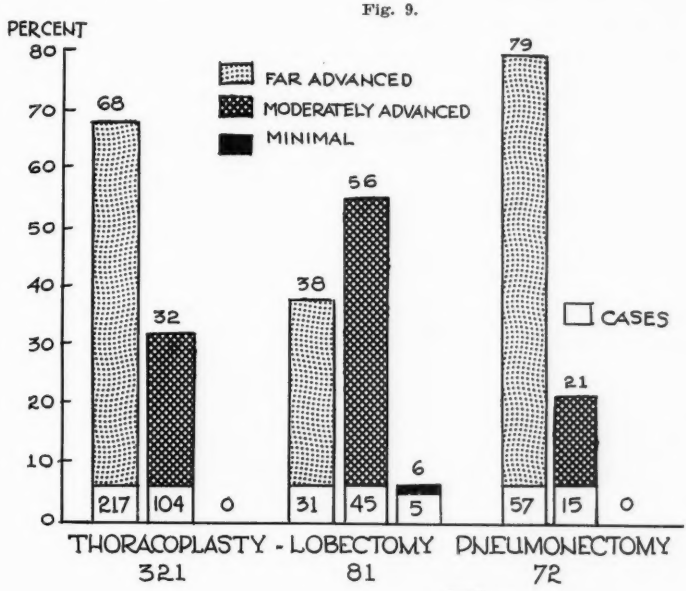


Fig. 10.

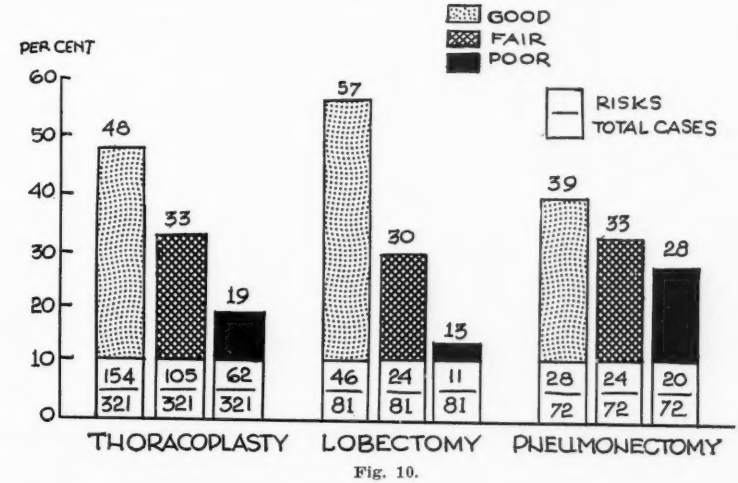


Fig. 9.—Comparison of extent of pulmonary disease treated by each surgical procedure.
Fig. 10.—Comparison of operative risks treated by each surgical procedure.

TABLE III. CAUSES FOR IMMEDIATE POSTOPERATIVE DEATHS

CAUSES	THORACOPLASTIES	PER CENT	LOBECTOMIES	PNEUMONECTOMIES	ALL RESECTIONS	PER CENT
Pulmonary						
Respiratory insufficiency	6	1.9	–	1	1	0.7
Atelectasis	5	1.7	–	1	1	0.7
Pulmonary embolism	3	0.9	–	2	2	1.3
Airway obstruction	1	0.3	1	–	1	0.7
Tuberculous pneumonia	3	0.9	–	–	–	–
Blown-out bronchial stump	–	–	–	1	1	0.7
Bacterial pneumonia	1	0.3	–	–	–	–
Lower Nephron disease	2	0.6	–	–	–	–
Cardiovascular						
Congestive failure	1	0.3	–	2	2	1.3
Cardiac arrest	1	0.3	–	–	–	–
Shock	1	0.3	–	1	1	0.7
Hemorrhage	–	–	2	–	2	1.3
Totals	24	7.5	3	8	11	7.4

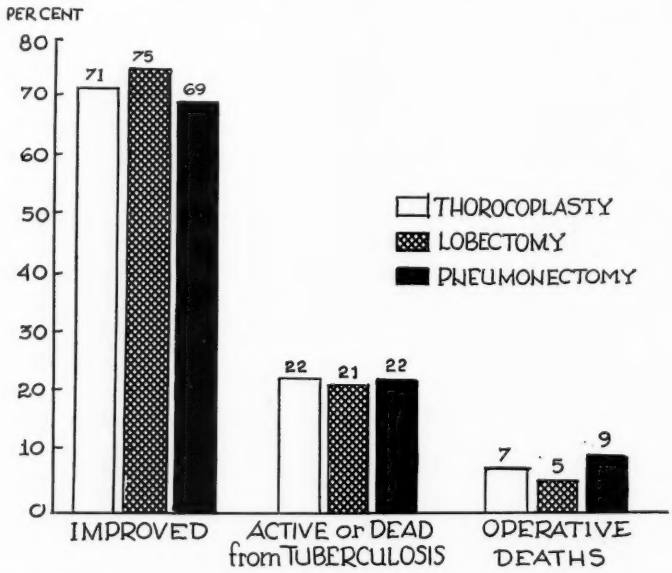


Fig. 11.—Comparison of mortality and salvage rates by surgical procedure after correction for *race, operative risk,* and *period of time.*

thoracoplasties or resections was progression of the disease (Tables IV and V). The remaining causes varied with the type of procedure, but the over-all case incidence in all procedures was essentially the same.

SUMMARY

A statistical review of 474 cases of major surgical therapy in pulmonary tuberculosis done during the ten-year period 1942 to 1951 has been presented. This included 321 thoracoplasties, eighty-one lobectomies, and seventy-two pneumonectomies.

TABLE IV. CAUSES FOR DELAYED POSTOPERATIVE DEATHS

CAUSES	THORACOPLASTIES	PER CENT	LOBECTOMIES	PNEUMONECTOMIES	ALL RESECTIONS	PER CENT
Spread or progression	21	6.5	6	3	9	5.9
Bronchopleural fistula	3	0.9	2	2	4	2.6
Empyema	3	0.9	–	1	1	0.7
Tuberculous meningitis	2	0.6	–	–	–	–
TB wound sepsis	1	0.3	–	–	–	–
Totals	30	9.2	8	6	14	9.2

TABLE V. CAUSES FOR CONTINUED POSTOPERATIVE TUBERCULOUS ACTIVITY

CAUSES	THORACOPLASTIES	PER CENT	LOBECTOMIES	PNEUMONECTOMIES	ALL RESECTIONS	PER CENT
Spread or progression	26	8.1	5	7	12	7.9
Cavity under thoracoplasty	14	4.4	–	–	–	–
Empyema	2	0.6	1	3	4	2.6
Extrapleural space infection	1	0.3	–	–	–	–
Totals	43	13.4	6	10	16	10.5

The major factors affecting the mortality and salvage rates were the *race* of the patient, the clinical *operative risk* of the patient, and the *period of time* during which the procedure was done. The period of time was an important factor because, after 1947, streptomycin and improved patient management increased the safety of surgery.

The presence of bilateral disease lowered the salvage rate of resection but did not influence the results of thoracoplasty. The N. T. A. classification of the pulmonary disease was a fair index for predicting surgical results.

Surgery done in the face of active endobronchial disease gave poorer results than operations performed after negative bronchoscopic findings or after the endobronchial disease had healed.

On the basis of our observations on operative mortality, surgical results, and postoperative complications, no one procedure for pulmonary tuberculosis can be favored over the others. Extrapleural thoracoplasty had a good record even when used without antibiotics and improved patient management. With the present advances in the management of pulmonary tuberculosis, lobectomy and pneumonectomy have results comparable to those of extrapleural thoracoplasty. The choice between collapse and resection therapy in the treatment of pulmonary tuberculosis will have to be made by criteria not studied in this paper.

The extent and character of pulmonary disease, the general condition of the patient, and the preoperative and postoperative care have a greater influence upon the results of surgery than the type of procedure chosen.

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DIVERTICULA OF THE ESOPHAGUS

A Study of Seventeen Cases

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ESOPHAGEAL diverticulum has been recognized as a clinical entity since the end of the eighteenth century. Therefore the more easily accessible extrathoracic esophageal diverticula have been surgically treated for many years before sufficient experience of intrathoracic surgery was gained to permit treatment of diverticula of the thoracic esophagus. Now various surgical procedures are generally accepted as appropriate treatment for these distressing anomalies.

According to their situation diverticula of the esophagus may be classed as:

1. Extrathoracic (pharyngo-esophageal, cervical), or
2. Intrathoracic.

The latter may be subdivided into: (a) diverticula of the upper esophagus (epibronchial), and (b) those diverticula affecting the lower esophagus (epiphrenic).

The extrathoracic types, according to Magendie, compose 90 per cent of all esophageal diverticula.

EXTRATHORACIC DIVERTICULA

Apart from the rare congenital cases, extrathoracic diverticula are seen almost exclusively in subjects over 50 years of age. It has been presumed that these commonest of esophageal defects are produced by mucosal herniation of the posterior portion of the pharyngoesophageal junction and from the anatomic point of view are really pharyngeal defects.

Various opinions have been expressed concerning their causal mechanism. According to Moynihan, vessels and nerves traverse the lower part of the constrictor musculature of the pharynx, and thus there arise muscle-free spaces with lessened stress resistance. Pressure changes in deglutition may then cause the mucosa to protrude through these spaces. In several autopsy studies Cortesi observed that one-third of the subjects of all ages showed poorly developed constrictor musculature. He suggested that the changes caused by aging added to this constitutional weakness might explain why extrathoracic esophageal diverticula are more common in later life. Rakitova (cited by Magendie) considered that ossification of the cricoid cartilage pressed the esophagus against the vertebral column. This little-accepted opinion might also explain the frequency of diverticula in older individuals, in whom the

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pressure of the hard cartilage could produce degeneration of the aging muscle. Holmgren's observation of roentgenographically visible, inconstant diverticulum-like changes in the border zone between the pharynx and the esophagus is interesting. Holmgren expressed the opinion that these changes were referable to anatomic conditions in the affected zone and pressure changes in and around the pharynx occasioned by deglutition. These changes might, he thought, be precursors of diverticula of this junction, despite the fact that no observations are recorded of such a preliminary stage in pharyngeal diverticula.

Even though the primary cause of extrathoracic esophageal diverticula is uncertain, it is known that the diverticula are progressively enlarged by repeated distention with swallowed food, so that in time the esophagus is obstructed and a vicious circle is established which can be broken only by extirpation of the defect.

Gross Pathology.—The pouch may vary in size from a few cubic centimeters to the size of a clenched fist. Its wall consists only of a mucous and a submucous layer. In the rare congenital cases, however, a muscular layer is also present.

Symptomatology.—The size and shape of the diverticulum are the determining factors in regard to symptoms. Broad-based, small diverticula produce only occasional and transitory symptoms when food particles of unsuitable consistency or size are retained. When the form becomes saclike with a true neck, food and swallowed air accumulate and symptoms, chiefly dysphagia and regurgitation, appear. Sometimes a gurgling noise is audible in the sac which, if large, may be felt on palpation. Often the patient manages for some time to dislodge the contents of the sac by certain movements of the head and neck. But when the diverticulum becomes so large that it interferes with nutrition, severe weight loss may result. A characteristic description of the condition is as follows: swallowing is fairly easy at the beginning of a meal, but becomes progressively more difficult until maximum dilatation of the diverticulum prohibits further consumption and the esophageal contents are vomited.

Diagnosis.—Although the symptoms may suggest a diverticulum, roentgenographic study is necessary to confirm the diagnosis. Esophagoscopy permits determination of the size and situation of the defect, but carries a risk of perforation.

Complications.—Mechanical and chemical irritation produced by distention of the sac and decomposition of the retained food give rise to a local esophagitis which, in rare instances, may result in perforation. Malignant degeneration may occur from chronic irritation.

The most important complications, however, are bronchopulmonary. A diverticulum which has filled during the day may, when the patient is asleep or otherwise in the supine posture, or when the pharyngeal reflexes are weakened, spill its contents into the air passages and give rise to aspiration pneumonia, lung abscesses, or bronchiectasis. The traumatic complications of esophagoscopy must also be listed as complications of esophageal diverticula.

Treatment.—Surgery is the therapy of choice. Early, symptom-free stages of the condition are mostly undetected and therefore untreated. When advice is sought for symptoms and the diagnosis confirmed by roentgenographic examination, radical excision of the diverticulum should be performed. Contraindications to surgery scarcely exist in these patients, although most of them have attained an age at which increased caution is necessary in the choice of therapy.

Should concomitant disease preclude radical excision, endoscopic cauterization of the wall dividing the esophagus and the diverticulum may be advisable in order to facilitate emptying (Dohlman). Malnutrition must be corrected. Antimicrobial therapy is given as routine in order to sterilize the operative field. In cases with severe retention, local therapy such as lavage of the sac must be given prior to operation.

Operative Procedure.—Extrathoracic esophageal diverticula may be excised under local anesthesia, but the advantages of this method probably are slight in comparison with the calm field and decreased risk of air embolism when endotracheal anesthesia with controlled breathing is employed. Various surgical procedures have been advocated: the sac has been invaginated (Girard and Bevan), fixed in a position of elevation (diverticulopexy according to Schmied), or with the aim of avoiding mediastinitis, removed in two stages (Lahey). One-stage excision, however, gives satisfactory results and, since it does not carry major risk, is to be advised.

Identification of the diverticulum at operation may be facilitated by placing a tampon in the sac; the sac is thereby distended and so contrasts in consistency with the surrounding structures. The diverticulum is dissected down to its junction with the esophagus. It is then excised and the esophageal wall closed in layers. Should any of the sac remain, the defect will, of course, recur. The risk of surgical stenosis is lessened if a stomach tube is passed through the esophagus; the ease with which the tube is inserted indicates the presence or absence of stenosis.

The stomach tube may be left in situ for postoperative feeding. If tube feeding is not favored, fluid may be given parenterally at first and water by mouth after the second day. The diet is then gradually increased until, after ten to fourteen days, the patient is able to eat ordinary food. Antibiotics are administered.

Surgical Complications.—Suture insufficiency with mediastinal contamination and fistula formation are the commoner postoperative complications. Injury to the recurrent laryngeal nerve may produce permanent or temporary aphonia. Recurrence of the diverticulum is a late complication.

Results of Operation in the Present Series.—In ten of the seventeen patients in this study extrathoracic diverticula were excised through a cervical incision. There was no surgical fatality. These cases are surveyed in Table I.

The ages of the patients ranged from 33 to 79 years; four were less than 50 years old and six more than 67 years old. All had had dysphagia for shorter or longer periods, and in two patients this was combined with regurgitation of food. Weight loss was not invariably reported, but one patient

TABLE I. EXTRATHORACIC DIVERTICULA

NO.	INITIALS	AGE AND SEX	SYMPTOMS	DURATION OF SYMPTOMS	PREOP. COMPLICATIONS	DATE OF OPERATION	P.O. COMPLICATIONS	RECURRENCE	PRESENT STATUS
1	G. W.	49 M	Dysphagia, regurgitation	4 yr.	–	2/ 9/34	Suture insufficiency, fistula	+	Symptom-free
2	G. G.	39 M	Dysphagia	1 yr.	–	9/27/34	–		Unknown
3	T. P.	35 F	Dysphagia	1½ yr.	–	9/16/36	–	+	Symptom-free
4	E. P.	79 F	Dysphagia	10 yr.	–	2/27/47	–		Symptom-free
5	G. K.	67 M	Dysphagia	20 yr.	–	1/14/48	–	–	Symptom-free
6	E. E.	69 M	Dysphagia	11 yr.	–	2/11/49	Paralysis of recurrent laryngeal nerve	–	Symptom-free
7	J. S.	74 M	Dysphagia, regurgitation	5 yr.	–	6/17/49	–	+	Symptom-free
8	A. H.	71 M	Dysphagia	8 yr.	–	7/ 7/49	–	+	Symptom-free
9	E. R.	33 F	Dysphagia	¼ yr.	–	1/25/50	–	–	Symptom-free
10	G. A.	70 M	Dysphagia	20 yr.	–	8/ 8/50	–	–	Symptom-free

had lost seventeen kilograms in four years and another about four kilograms weekly for some weeks prior to operation. The diagnosis was confirmed by barium study and esophagoscopy. None of the patients gave a history of, or showed on examination, the common bronchopulmonary complications, although in some the duration of dysphagia was very long and the diverticulum larger than a clenched fist. Such complications were sought for particularly in the chest roentgenograms.

The preoperative diet was fluid or bland, so as to reduce retention in the diverticulum. Protein and vitamin deficiencies were made good by parenteral administration and, if necessary, the pouch was washed out after meals. Antimicrobial agents were given when available.

A. *B.*

Fig. 1.—(Case 1.) Barium study eighteen years after excision of an extrathoracic esophageal diverticulum. Preoperative roentgenograms were not obtainable.

Local anesthesia was employed in the first three operations. Since 1947, however, all surgery has been performed under endotracheal anesthesia. The diverticula were excised in one stage. Drains were inserted only in the first three cases. In one of these a Witzel operation was first performed.

Paralysis of the recurrent laryngeal nerve occurred as a surgical complication in one patient. In another suture insufficiency caused a fistula to appear on the fourteenth postoperative day; during repair of the fistula the recurrent laryngeal nerve was injured and persistent paralysis resulted.

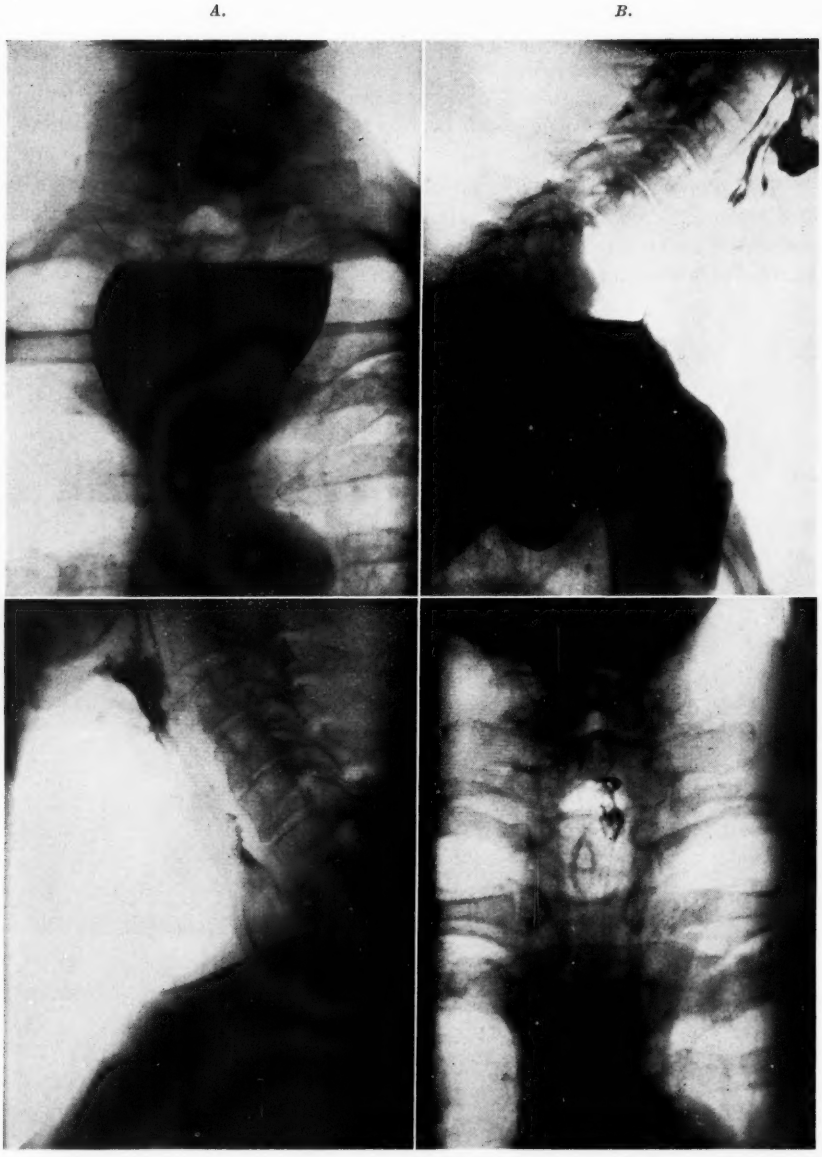

Fig. 2.—(Case 10.) *A* and *B*, Preoperative barium study. *C* and *D*, Postoperative barium study.

Five of the excised diverticula were histologically examined. In addition to chronic inflammation, a complete, or almost complete, absence of muscle in their walls, indicating mucosal herniation, was noted.

Eight of the ten patients presented themselves for follow-up roentgenographic study in 1952. Of the other two, one patient (Case 4) had died of cardiovascular disease but had had complete relief of symptoms, and the other (Case 2) is in a mental hospital. In four patients (Cases 1, 3, 7, and 8) the roentgenograms showed recurrence of the diverticulum in loco. The second defect measured 25 by 30 mm. in Case 1 (Fig. 1); it was 30 by 40 mm. in Case 3, 6 by 15 mm. in Case 7, and 15 by 20 mm. in Case 8. However, all eight patients reported freedom from symptoms.

For some time after the excision of a diverticulum the roentgenogram shows changes which bear some resemblance to a recurrence of the sac. The recurrences discussed here, however, were bulges in the esophageal wall in which barium was retained on roentgenographic examination a fairly long time after the operation. Fig. 2 shows the roentgenograms before and after the operation in Case 10.

Relief of symptoms after operation is no guarantee of freedom from recurrence. Roentgenograms give the only reliable information in this respect. Meticulous excision of the diverticulum is of cardinal importance for the prevention of recurrence. The smallest spur left behind provides conditions for regrowth, since surgery does not eradicate the etiologic factor. The one-stage operation, provided routine asepsis and antimicrobial agents are employed, carries a practically negligible risk of infection. The patients in this series were allowed small quantities of water by mouth in the immediate postoperative period. It is probable that since the suture line is cleansed, this procedure is more favorable for the postoperative course than tube feeding.

INTRATHORACIC DIVERTICULA

Diverticula of the thoracic portion of the esophagus are relatively rare. According to Magendie they comprise 10 per cent of esophageal diverticula.

A. Epibronchial Diverticula

These are the least common of intrathoracic diverticula. They are found chiefly in the region of the tracheal bifurcation.

Divergent theories have been advanced to explain the etiology of epibronchial diverticula. One of the earliest published theories was that of Kragh who, from autopsy observations, considered that the defect was produced by adhesion of the esophagus to a tuberculous lymph node which, when healing by scar retraction, exerted a pull on the esophagus and gave rise to a "traction diverticulum." Kragh also stated that the tuberculous node could perforate into the esophagus and epithelization of the abscess cavity could take place from the esophageal mucosa. Kragh's view was to some extent contradicted by Ribert (cited by Perrotin), who pointed out that since tuberculous lymphadenitis was most common in childhood, it would be expected to see more traction diverticula in children than in adults.

Whatever the actual causal mechanism, a pulsation factor to the development of the diverticulum is added by swallowed food. A congenital defect, in which secondary infection produces adhesion to adjacent structures cannot, of course, be excluded. Contrasted against congenital causes there is the fact that symptoms generally do not appear until fairly late in life, but it is known that esophageal diverticula may be silent for many years. Each theory contains, no doubt, some truth, and it is probable that several etiological factors operate together. Pathologic and histologic study do not elucidate the question.

Gross Pathology.—Most epibronchial diverticula are small and cone-shaped, with the base opening into the esophagus. As a rule all coats of the esophagus are found in the pouch which may be free from inflammatory changes but which is usually firmly adherent to the adjacent tissues. In some cases there is fistulation to the lungs or bronchi.

Symptomatology.—These diverticula may be incidental findings in a search for another disease. Symptoms directly referable to an esophageal anomaly are fairly unusual, but they may be manifested as dysphagia or a feeling of tension or pain in the chest. The severity of the symptoms varies with the filling and emptying of the esophagus and with the presence or absence of infection. The symptoms of infection may quite overshadow those of the diverticulum as such. Since the history gives little help in establishing the diagnosis, barium study and/or esophagoscopy must be undertaken.

Complications.—Patients who seek medical advice for this condition generally do so when complications have occurred. Infection, the commonest complication, may gradually produce perforation of the diverticulum with fistulation to adjacent organs. Bronchiectasis and lung abscesses which appear to be primary conditions may have their origin in perforation of such an esophageal diverticulum. Malignant degeneration of the diverticular mucosa is a possibility not to be ignored.

Treatment.—When a fistula has formed, surgical intervention is clearly indicated. It is not clear whether or not silent diverticulum which is discovered accidentally should be excised. The consensus of opinion in the literature seems to be that regular roentgenographic observation is adequate. If symptoms have appeared, excision is advocated; if there is fistulation to the lung, lobectomy or segmental resection to eradicate the infection should be performed. Diverticulopexy and invagination of the sac were previously employed but have now fallen into disuse.

The principles outlined for the preoperative treatment of extrathoracic diverticula apply also to the epibronchial variety.

Excision of uncomplicated diverticula is carried out through a thoracotomy incision which is closed without drainage. When lung tissue is resected underwater suction drainage is generally employed.

The postoperative management of such patients, therefore, is not notably different from that following pulmonary surgery for other conditions. Fluids are given as stated previously.

Surgical Complications.—In addition to insufficiency of sutures and mediastinal contamination, these patients may develop the postoperative complications of all intrathoracic interventions: atelectasis, pleural effusion, and bronchopleural fistula.

B. Epiphrenic Diverticula

These diverticula, as the name implies, are located in the lower portion of the esophagus, just above the diaphragm. They would appear, from the literature, to be the most common of the intrathoracic diverticula, although up to May, 1951, only 126 cases had been described (Goodman and Parnes).

Pulsion is the causal factor; but why pulsion should produce a diverticulum at this particular point is not quite clear. Congenital weakness of the esophageal wall, localized esophagitis, and disturbance of the neuromuscular function in the esophagus have been suggested as explanations. According to Goodman and Parnes, about 65 per cent of epiphrenic diverticula are associated with cardiospasm.

Gross Pathology.—Although various sizes of epiphrenic diverticula are found, they are fairly large as a rule. They may be single or multiple. All coats of the esophagus are present in their walls, with the muscular layer showing the poorest development.

Symptoms.—The severity of the symptoms ranges from very slight to grave, with considerable loss of weight and inanition. Frequently the symptoms are not clearly related to the esophagus but are those of all disturbances of the upper alimentary canal. Dysphagia, regurgitation, epigastric pain, vomiting, a feeling of abdominal fullness, belching, cardiac distress, and cough are the most common symptoms of epibronchial diverticula.

Roentgenographic studies and esophagoscopy are again the diagnostic aids. Conditions to be eliminated from the diagnosis include diaphragmatic hernia.

Complications.—Infection of the contents of the diverticulum may lead to ulceration of its walls and, rarely, to malignant changes. Bronchopulmonary complications arise chiefly from perforation into these organs. According to the French literature, perforation is more common in diverticula projecting to the right of the esophagus than in those presenting to the left. Monod observed three cases with esophagobronchial fistula, all of which appeared on the right side.

Treatment.—With the possible exception of small, accidentally discovered symptomless diverticula, surgical intervention should be undertaken. But even such silent diverticula are likely to require operation at a later date. The weak point in the esophageal wall remains and the contributory pressure factor within the lumen will enlarge a small sac until symptoms necessitate operation. The risk of malignant degeneration also remains until the diverticulum is excised. Antispasmodics and local palliative therapy have their place as preliminary measures for surgery.

Extrapleural resection, invagination, diverticulopexy, diverticulogastrostomy, resection of the distal portion of the esophagus, and esophagogastros-

TABLE II. INTRATHORACIC DIVERTICULA

NO.	INITIALS	AGE AND SEX	SYMPTOMS	DURATION OF SYMPTOMS	PREOP. COMPLICATIONS	DATE OF OPERATION	P.O. COMPLICATIONS	RECURRENCE	PRESENT STATUS
1	E. J.	30 F	Recurrent pneumonia	4 yr.	Bronchiectasis	3/ 6/45	–	–	Symptom-free
2	K. L.	41 F	Lung abscess	9 yr.	Lung abscess	5/21/47	–	–	Symptom-free
3	A. E.	53 M	Dysphagia	½ yr.	–	4/23/48	–	–	Symptom-free
4	M. J.	55 F	Recurrent pneumonia	12 yr.	Esophagobronchial fistula	5/16/49	–	–	Symptom-free
5	R. S.	60 M	Regurgitation	20 yr.	–	2/ 1/51	–	–	Unimproved
6	A. L.	61 F	Recurrent pneumonia	7 yr.	Esophagobronchial fistula	2/ 7/52	–	–	Symptom-free
7	E. J.	50 F	Dysphagia	5 yr.	–	4/18/52	–	–	Symptom-free

tomy are among the surgical procedures described for the condition. The last-named operation was recommended by Goodman and Parnes for multiple diverticula and diverticula associated with esophageal atresia or cardiospasm.

In regard to the surgical complications and postoperative management of these cases, reference is made to what has been said concerning epibronchial diverticula.

We have never encountered epiphrenic diverticula in operations for correction of cardiospasm, which would seem to indicate an infrequent association of cardiospasm with such defects.

Results of Operation in the Present Series

The seven intrathoracic diverticula in this series were of the epibronchial type. There was no surgical fatality. The cases are listed in Table II.

The youngest patient was 30 and the oldest 61 years of age; the majority were between 50 and 60 years old. In three cases the dominant symptom was difficulty in swallowing food beyond a definite retrosternal point. A history of recurrent pneumonia or lung abscess was noted in the others. In two patients (Cases 2 and 6) a lung abscess had previously been incised and a residual external fistula repaired. The condition recurred due to infection from a persistent esophagobronchial fistula, and the patients came to operation on a diagnosis of lung abscess with external fistula. The association with a perforated esophageal diverticulum was discovered when the chest was opened. In another patient (Case 1) the preoperative diagnosis was bronchiectatic cavitation of the lung, and here also an esophagobronchial fistula constituting the remains of a diverticulum was found at operation.

Bronchoscopic and roentgenographic search for an esophagobronchial communication had been made prior to operation in these patients. Such cases stress the possibility of an association between bronchopulmonary disease and esophageal diverticula. Histologic examination confirmed the diagnosis in all seven cases.

All the patients were alive and without roentgenographic sign of recurrence at follow-up examination in 1952. All but one (Case 5) were symptom-free. This patient claimed no relief from symptoms, thus demonstrating the necessity of taking into account a possible psychasthenic factor when assessing the incidental find of an esophageal diverticulum.

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BENIGN CYSTIC THYMOMA

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PRIMARY tumors of the mediastinum are relatively rare. Ackerman and Regato[1] report that teratoma and dermoid cysts are the most common anterior mediastinal tumors, while tumors of nerve origin predominate in the posterior mediastinum. These authors list thymic neoplasms as the third most common tumor of the mediastinum. For this reason it is felt that the report of a 1,000 c.c. cystic thymoma is warranted.

Homburger[2] reported the occurrence of forty-one instances of thymic tumor or enlargement of the thymus in 6,000 necropsies of which only five were true tumors. Symmers[3] found twenty-four thymic tumors in 17,000 necropsies at Bellevue Hospital. The files of the Lahey Clinic contain six cases of thymic tumor discovered in the course of some 300,000 clinical examinations, not including infants.[4]

Thymic tumors, because of their rarity and diversity, have long resisted attempts at rational classification. As one observer usually has the opportunity to study only a few lesions and because there is difficulty in interpretation of the structure, it is not surprising that various points of view concerning the nature of thymic tumors have been expressed. Several series and numerous cases are on record, but it is impossible to reach valid conclusions from this variously described and variously interpreted material.

The thymus weighs 10 to 12 grams at birth and reaches its maximum size of 30 to 40 grams at puberty, after which the lymphoid elements undergo involution.[7] There are great variations in the total weights of normal thymus glands and in actual amounts of thymic tissue and adipose tissue present in glands of similar weight.

From each of the histologic elements of the thymus a particular sort of malignant tumor is capable of arising: carcinoma or epithelioma from the epithelial reticulum, and lymphomas from the lymphocytic elements. Since the thymus is a constituent of the reticuloendothelial system, it is not surprising to find that its residua are capable of transformations to lymphosarcoma and Hodgkin's disease.

It is generally agreed that the thymus, at least in the adult, is a nonessential organ. Many interesting studies have been performed in an attempt to determine the function of the thymus, but despite the large number of clinical and experimental observations, the function of the thymus still is unknown.[9]

From the Surgical Service, Brooke Army Hospital.
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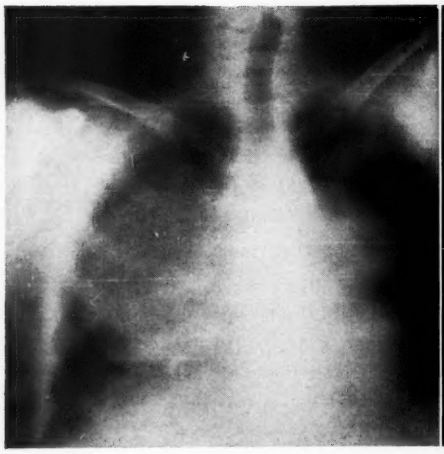

Fig. 1.

Fig. 2.

Fig. 1.—Planographic study shows the large thoracic shadow mostly in the right chest, but with an extension to the left.

Fig. 2.—Lateral chest film shows the mass to be anteriorly placed. The esophagus was not displaced as evidenced by normal position on barium swallow examination.

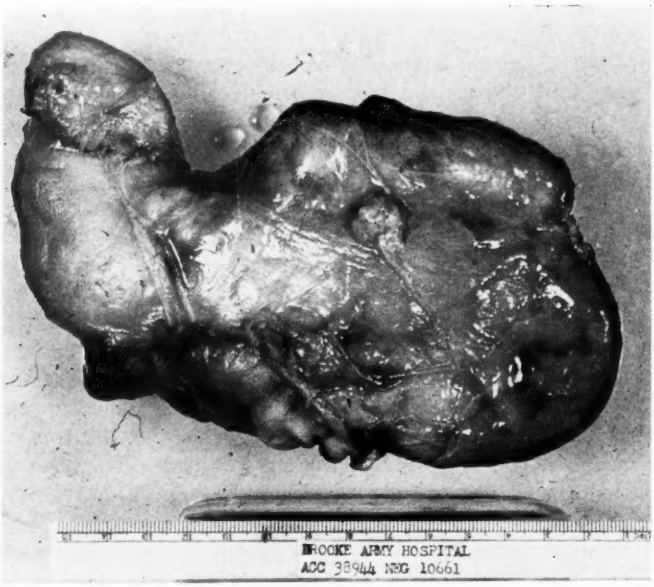

Fig. 3.—The gross specimen measured 18 by 9.4 by 6.4 cm. and was a thin-walled cyst with several masses of solid tissue in its wall.

That there may be more than a casual relationship between myasthenia gravis and abnormalities of the thymus is suggested by an increasing number of reports in recent years regarding benign nd malignant tumors of the thymus in patients with myasthenia gravis.[13, 14] Bell[10] and Norris[11] reviewed the reported autopsied cases of myasthenia gravis and observed an incidence of 50 per cent with thymic enlargement or tumor.

CASE REPORT

A 28-year-old white Air Force captain was admitted on Dec. 9, 1952, because of a large anterior mediastinal mass noted on routine chest x-ray examination on Nov. 20, 1952. Except for very slight shortness of breath on exercise and occasional substernal burning when straining or lifting during the month previous to admission, the patient was completely asymptomatic.

The patient's general health had always been excellent. Past military, medical, and family histories were noncontributory. No history of familial myasthenia gravis was obtained.

Physical examination on admission revealed decreased breath sounds and decreased fremitus in the parasternal areas anteriorly bilaterally. This region was dull to percussion. Otherwise the physical examination was entirely normal.

Laboratory studies, including complete blood count, sedimentation rate, hematocrit, clotting and bleeding time, and serologic examination, were all negative or normal. Sputum studies and skin tests for tuberculosis and fungi were not remarkable. An electrocardiogram was interpreted as normal. Routine x-ray studies, laminography, angiography, and fluoroscopy with a barium swallow all confirmed the presence of a large oval anterior mediastinal mass extending from the right lower to the left upper aspect of the sternum (Figs. 1 and 2). There was no evidence of pulsation of the mass or connection with the pulmonary or mediastinal vessels, or with the esophagus or the pericardium.

On Dec. 16, 1952, exploratory thoracotomy was performed (W. F. B.) through the bed of the right fourth rib anteriorly. A large thin-walled cyst presented anteriorly containing an estimated 1,000 c.c. of yellow brown opalescent fluid containing fine cholesterol crystals; 875 c.c. of this fluid were aspirated, and in spite of extension of the cyst well to the left of the sternum, it was removed intact (Fig. 3). There was a small pedicle at the cephalad aspect of the cyst which contained three moderate-sized vessels. The patient received 1,000 c.c. of whole blood and withstood the operation well. Underwater sealed drainage was utilized for twenty-four hours, and the lung expanded satisfactorily. The patient was out of bed on the second postoperative day, and at the end of a week the wound was healed per primam and he was free of symptoms. The patient was discharged to duty on Dec. 30, 1952.

In summary, the pathologist reported an 18 by 9.4 by 6.4 cm. thin-walled cystic mass. There were three fragments of soft gray-red tissue on the inner aspect of the cyst, the largest measuring 3.5 by 2.1 by 1.2 cm. Microscopic examination of the areas of solid tissue revealed lymphoid tissue without distinctive architecture. In this lymphoid stroma there were multiple spherical areas of deep pink staining tissue appearing to be hyalin deposition with a surrounding deep pink wall of low cuboidal cells. These were interpreted as typical Hassall's corpuscles (Fig. 4). Sections of the cyst revealed a thin layer of small, round, blue cells, apparently lymphocytes, as the lining. The wall of the cyst was very thin and external to it there was a layer of areolar tissue containing a small amount of lymphoid stroma (Fig. 5). Pathologic diagnosis was mediastinal cyst—thymoma.

DISCUSSION

In the preoperative evaluations of this patient a thymic tumor was considered. However, after thoracotomy revealed that the gross specimen was a large cyst we were surprised at the microscopic diagnosis of thymoma.

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In reviewing the literature we find only one other benign thymic tumor of epithelial anlage origin which is similar to the one described. Blalock and coworkers[12] reported a smaller benign cystic thymoma in a patient with myasthenia gravis. Although there was no microscopic evidence of thymic tissue in their case, it was assumed from the position of the mass and from the clinical relationship to myasthenia gravis that the tumor represented a necrotic thymic

Fig. 4.

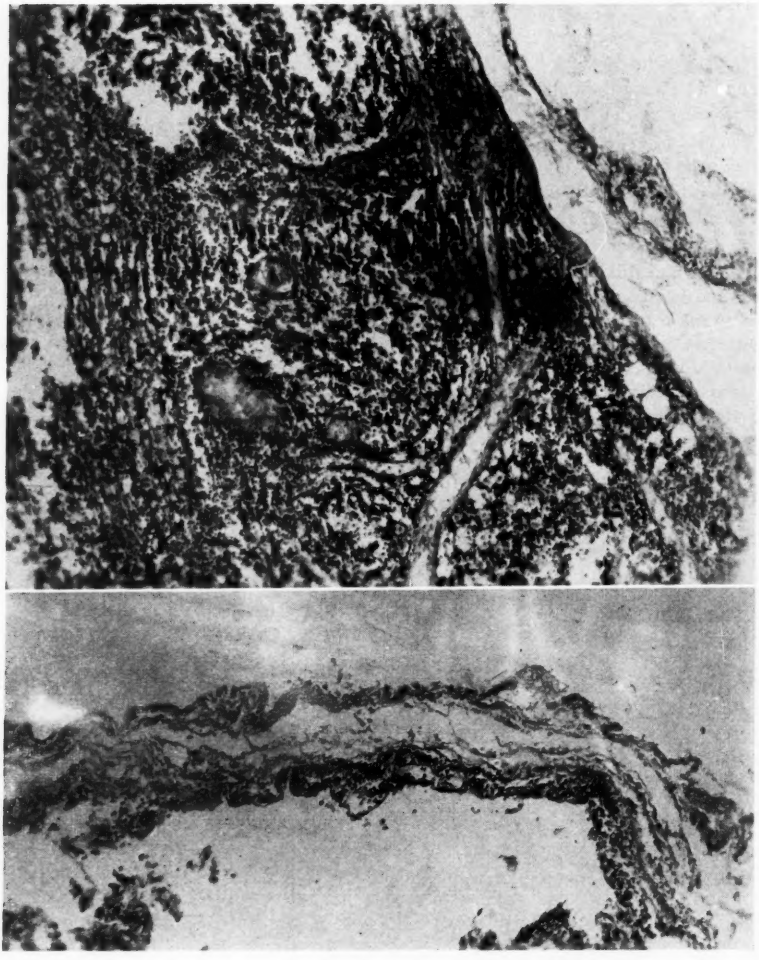

Fig. 5.

Fig. 4.—The solid tissue in the cyst wall showed typical thymic tissue containing Hassall's corpuscles.

Fig. 5.—The cyst wall was very thin, with lymphoid tissue in its wall, surrounded by areolar tissue.

tumor. It is significant, however, that the cystic degeneration in their case might reasonably be explained on the basis of previous roentgen-ray irradiation.

In view of the gross extent of the tumor in our patient, it is interesting that he was asymptomatic. In some reported cases there have been no symptoms, while in others there have been dyspnea, cough, cyanosis, and pain, depending upon the size and location of the tumor. Usually these symptoms are not primarily due to the tumor itself, but reflect pressure phenomena on other mediastinal structures.

SUMMARY

1. A case of a 1,000 c.c. benign cystic thymoma is presented.

2. It is thought that this case represents the largest cystic thymoma reported to date.

3. From a review of the literature it would appear that large cystic thymic tumors are a rare occurrence.

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PRIMARY LYMPHOSARCOMA OF THE LUNG

A Report of Two Cases

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VERY few reports of primary lymphosarcoma in which the lung was the site of origin have appeared in the literature. In two large series of malignant lymphomas reviewed about a decade ago,[1, 2] only one case (from a total of 814) was considered to have arisen from the pulmonary parenchyma. Since that time, seven other cases have been recorded.[3-9] (Beck and Reganis supplement their case report with data concerning eight additional cases treated but not reported by other surgeons.)

At the University of California Hospital, two patients with primary lymphosarcoma of the lung have been operated upon in the past twenty-two years. A discussion of these two cases is presented for analysis of their diagnostic and therapeutic characteristics.

CASE REPORTS

Case 1.—M. K., a 68-year-old housewife, entered the University of California Hospital for the first time in March, 1951, complaining chiefly of a cough which had been present for eight months and of hemoptysis of three months' duration. The patient had some exertional dyspnea associated with these symptoms and had lost eight pounds. No pleuritic pain, chills, fever, or night sweats had occurred. The patient denied the use of nose drops with oil bases or the inhalation of foreign material. The past history, family history, and system review were noncontributory.

Positive findings on physical examination were confined to the thorax. Diminished vocal fremitus and dullness were present on the left side. Breath sounds were of increased volume and pitch, and crepitant and subcrepitant râles were audible over the posterior inferior left lung field.

Routine laboratory work showed a normal blood and differential leukocyte count. Urinalysis was normal, and the Kahn and Kolmer tests were negative. X-ray films of the chest (Fig. 1) revealed consolidation of the left lower lung field. On the lateral projection, the mass seemed to be limited to the left lower lobe.

Bronchoscopic examination demonstrated that the tracheal carina was displaced to the left. An area of neoplastic tissue was observed in the proximal portion of the left lower lobe bronchus. Histologic study of a biopsy specimen obtained from this area showed only fragments of connective tissue infiltrated with lymphocytes.

At operation, the left lower lobe was found to be smaller than normal, and it did not expand on inspiration. A solid mass of neoplastic tissue completely filled the area from the hilus to the periphery. The process also infiltrated the hilar area of the left upper lobe; the entire upper lobe showed diffuse involvement, although not as dense as that in the lower lobe. A left pneumonectomy was performed. None of the mediastinal nodes were grossly involved.

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When examined in the pathologic laboratory, the specimen consisted of a firm, grayish-white, lobulated mass with indefinite margins. On cut section, the surface was pearly gray, glistening, and presented a solid infiltrating picture. The pleura was intact.

Microscopic sections (Fig. 2) showed a solid mass of lymphoid cells which completely replaced the lung parenchyma. The cells were larger than mature lymphocytes, with minimal cytoplasm, vacuolated nuclei, and well-defined nucleoli. Mitotic figures were frequent. There was almost no stroma and the bronchial cartilages were eroded by the tumor. The diagnosis of lymphosarcoma with primary origin in the pulmonary parenchyma was made.

Postoperatively, the patient received x-ray therapy in the amount of 2000 r to the left mediastinal area anteriorly and posteriorly and was discharged in good condition.

She was last seen two years postoperatively. Physical and chest x-ray examinations at that time demonstrated no evidence of recurrence.

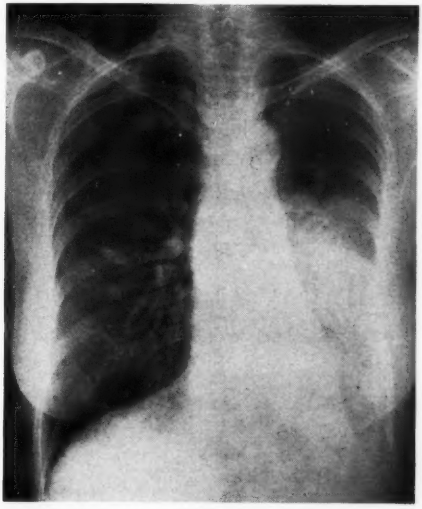


Fig. 1.—Note the ill-defined, hazy density in the left lower lung field.

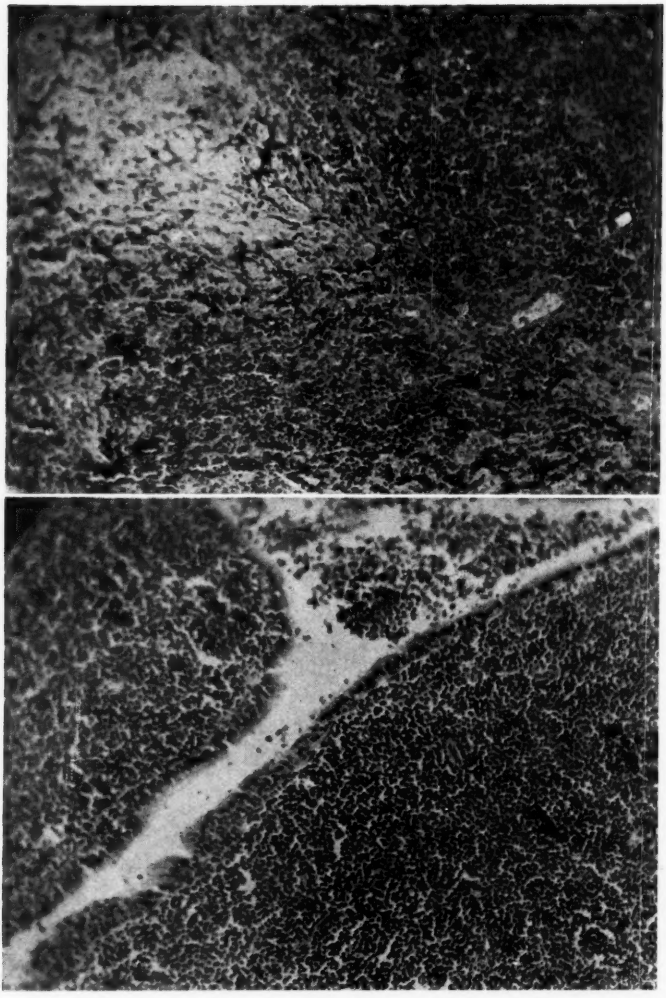
CASE 2.—E. R., a 45-year-old woman, entered the University of California Hospital for the first time in May, 1948, for investigation of an asymptomatic mass in the left chest which had been demonstrated by a routine chest x-ray examination one and one-half months before entry.

After discovery of the mass, the patient became aware of intermittent aching pain in the left chest which radiated to the interscapular region. Three isolated episodes of blood-streaked sputum had occurred one and one-half years previously, without other associated cardiorespiratory complaints. There had been no recognized weight loss.

Physical examination was entirely negative, as were the laboratory studies, including cytologic examination of sputum. The tracheobronchial tree was normal throughout by bronchoscopic examination. The roentgen-ray films of the chest (Fig. 3) demonstrated a mass in the left hilar region, with streaks of dense tissue extending toward the periphery. There was a small area of calcification overlying or within the mass.

On the basis of these findings, a left pneumonectomy was performed. A firm tumor mass, 6.0 cm. in diameter, was found arising from the anteromesial portion of the left upper lobe. The tumor had penetrated the visceral pleura, and numerous enlarged hilar

A.



B.

Fig. 2.—*A*, The lung parenchyma is almost totally replaced by tumor tissue. *B*, A generous capillary network is seen throughout the section. Note the massive infiltration by the lymphocytic cells.

nodes overlay the pulmonary artery. The mass was firmly adherent to the hilar structures, and there were dense vascular adhesions between the tumor and the aorta.

The pathologic report indicated that the tumor extended to the anterior surface of the lung. Its site of origin lay approximately 1.0 cm. distal to the region of the take-off of the upper lobe bronchus from the main-stem bronchus on the left. The bronchi had smooth, pinkish-gray mucosa and were not grossly involved. The hilar nodes were soft, edematous, anthracotic, and contained no metastases.

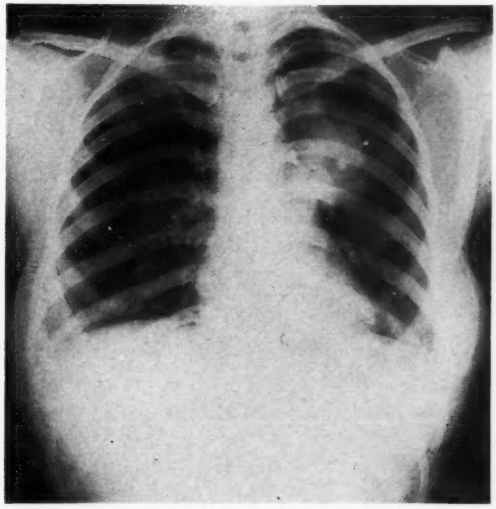


Fig. 3.—Note the well-defined mass in the left hilar region. The peripheral streaking was a prominent feature on the x-ray film.

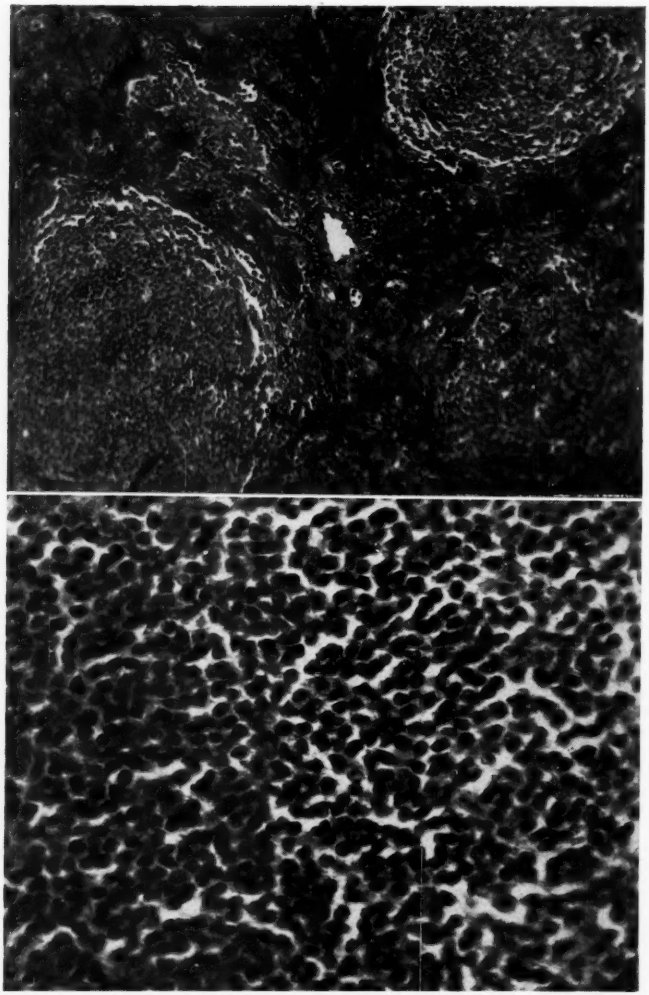
Microscopic sections (Fig. 4) showed that the tumor was composed of a solid sheet of fairly uniform cells, which varied only slightly in size. The cells had large oval nuclei with delicate chromatin and one to two nucleoli. Mitoses were rare. The cytoplasm was scanty, and small capillaries ran through the tumor. In some areas, large amounts of hyaline collagenous connective tissue were present. It is significant that none of the hilar lymph nodes were involved by the malignant process. The pathologic diagnosis was primary lymphosarcoma of the lung.

The patient's postoperative course was uneventful. She received no radiation therapy. When last seen five years postoperatively, there was no demonstrable evidence of recurrence, either by physical or chest x-ray examination.

DISCUSSION

Of the two patients observed at the University of California Hospital, both had symptoms referable to the respiratory system. In one case, as in four of the cases previously reported, the patient sought medical consultation which led to diagnosis of the complaint. In the other case, as in three of those previously reported, the lesion was first demonstrated by a routine chest survey film. Both of our patients were women, as have been a preponderant number of those previously reported. Our patients were 68 and 45 years of age, respectively. The age range in the cases previously reported was 34 to 68 years, with an average age of 46 years.

A.



B.

Fig. 4.—*A*, Large amounts of hyaline connective tissue arranged in strands can be seen between islands of tumor tissue. *B*, The uniform appearance of the cells is evident.

As would be expected, cytologic studies were negative in both of our cases. This is probably due to the fact that lymphosarcomas do not tend to exfoliate cells as do bronchiogenic carcinomas. Even when lymphosarcoma is suspected, however, cytologic examination should be performed, since the diagnosis is only presumptive until the tumor is examined at operation and in the pathologic laboratory.

It is our opinion that wide excision by pneumonectomy accompanied by mediastinal lymph node dissection is the treatment of choice for primary lymphosarcoma of the lung. The use of postoperative irradiation therapy to the mediastinal lymph node-bearing area must be considered since lesions of this type respond favorably to x-ray therapy.

The prognosis appears to be significantly more favorable in patients with primary lymphosarcoma of the lung than in patients having bronchiogenic carcinoma.

SUMMARY

The case histories of two patients with primary lymphosarcoma of the lung are presented. Although the period of follow-up is not yet sufficient for incontrovertible evaluation, it appears that primary lymphosarcoma of the lung can be treated effectively by either extensive surgery alone or in combination with postoperative x-ray therapy.

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ACQUIRED NONMALIGNANT ESOPHAGOTRACHEOBRONCHIAL FISTULA

Report of Two Cases

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THE causation and pathology of nonmalignant fistula formation between the esophagus and tracheobronchial tree has been well discussed previously by several authors.[1-3] Coleman and Bunch,[3, 4] in 1950, reported seventy-five cases from the literature and their own experience. Since that time, seven additional cases have been reported. The location of these lesions, together with our two, and the forty-four in Coleman and Bunch's series in which location was known, is shown in Fig. 1: a total of fifty-three lesions.

Tables I and II (after Coleman and Bunch) show the etiology of the whole presently reported series of eighty-four cases. Of particular interest were the reports of Maier,[6] who felt that broncholiths might possibly be causative in his two cases; and Paviot and Demirleau,[10] who reported a case of fistula secondary to extrapleural Lucite ball plombage. Two cases were reported in a discussion by Abbott,[11] which are not included in this series because of minimal data.

Table III brings up to date the surgical management of this condition. Of the nine new patients, one was cured by cauterization and one (following a lye burn) by exclusion of the damaged esophagus and fistula. Three patients were cured by pulmonary resection and closure of the esophagus. Division of the fistula with closure of both trachea and esophagus was performed in four cases, with two deaths, including one of the authors' cases.

Case 1.—L. T. (VAMTG, 82 878) was a 30-year-old white man who had been in an automobile accident on March 24, 1953. He was unconscious for two hours, was taken to another hospital, and then transferred on the following day. Vital signs were normal on admission. The neurological examination was negative. There were numerous abrasions and lacerations. Anteriorly at the base of the neck, there was ecchymosis, swelling, and subcutaneous emphysema. The hypopharynx was bluish, as if discolored by blood, although no bulging was present. There was some edema of the larynx, resulting in partial respiratory obstruction.

All routine laboratory studies were normal. Admission chest films showed blunting of both costophrenic angles, but there were no other significant findings. The patient required a tracheotomy shortly after admission because of laryngeal edema and was started on penicillin, 600,000 units per day, and streptomycin, 1 Gm. per day. He was able to tolerate a soft diet for four days. At this point he suddenly began vomiting ingested food through the tracheotomy tube. Oral feeding was stopped and Levine tube feedings were then attempted. This caused regurgitation through the tracheotomy. However, we were able to pass the tube through the pylorus and, in this position, most of the feedings were retained. We were able to maintain nutrition and fluid balance fairly well with

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daily supplements of intravenous fluids and frequent transfusions. The patient easily learned to suction himself and was no problem from the standpoint of retained secretions.

On April 22, 1953, esophagoscopy and bronchoscopy revealed a well-epithelized fistula about 1½ inches above the tracheal carina. This was felt to be well below the lowest

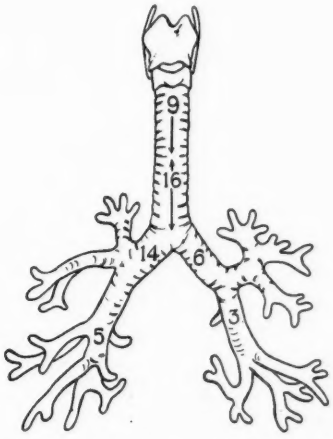

Fig. 1.—Anatomic location of esophagotracheobronchial fistula in fifty-three reported cases.

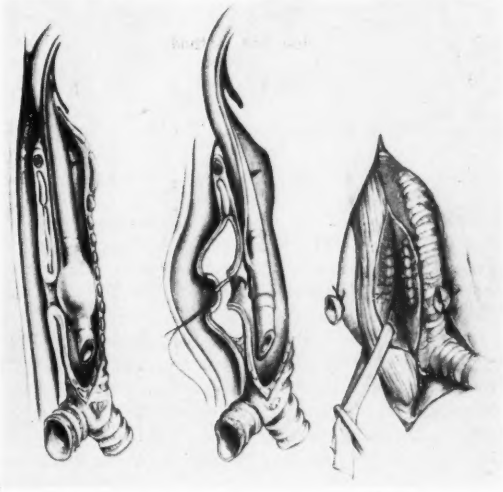

Fig. 2.—Anatomic situation and method of repair in Case 1.

extent of the tracheotomy tube and almost certainly due to the original trauma. On April 28, 1953, the fistula was closed (Fig. 2). A right lateral approach through the bed of the fourth rib gave excellent exposure and allowed easy closure of the trachea and esophagus after separation. One row of 000 braided silk sutures was used to close the trachea, and two rows of the same material were used to close the esophagus. Pleural flaps were used to cover both closures.

The patient had an entirely uneventful course postoperatively. The tracheotomy tube was removed on the second day and the defect closed spontaneously within a week. A Levine tube was left in the esophagus for forty-eight hours and then removed; after this the patient was able to eat a progressively expanded diet. He rapidly regained preoperative weight and has returned to work.

CASE 2.—W. McC. (VAMTG, 84 341) was a 34-year-old Negro man who was admitted on April 30, 1953. He complained of periumbilical pain eight hours before admission and vomiting one cupful of dark blood. He had experienced this pain on several previous occasions but apparently no other symptoms. The patient was very feeble-minded and no further history could be elicited.

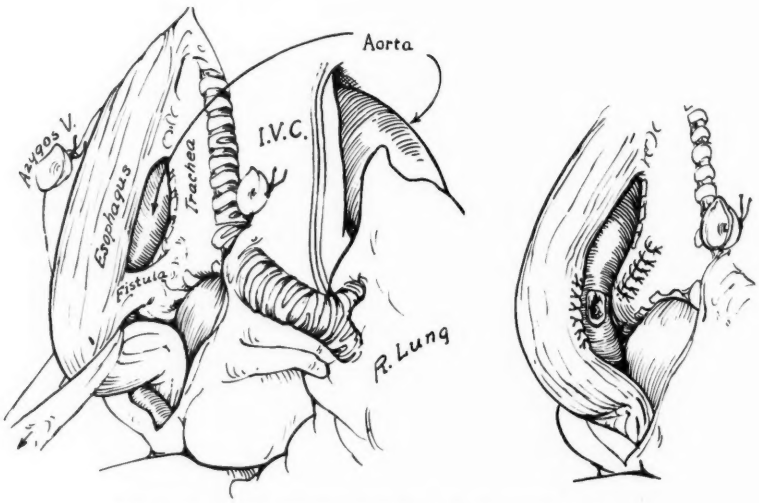

Fig. 3.—Anatomic situation and method of repair in Case 2.

Physical examination revealed an undernourished, acutely ill man. Temperature was 100° F. and pulse 90. The pharynx was inflamed and partially covered with a whitish membrane. Hemogram was normal except for a 17,300 white blood count. Throat culture revealed a streptococcus and *Staphylococcus aureus*. No diphtheria bacilli were present. Sputum culture revealed a streptococcus and Friedlander's bacillus. Chest x-ray examination on admission was negative. The patient was placed on penicillin therapy and the pharyngitis promptly cleared. One week after admission he again began to vomit. Temperature spiked to 104° F. and a chest film showed pneumonitis at the left base. Vomiting occurred only immediately after eating. A Levine tube was passed and he was fed successfully via this tube. Aureomycin was added to the antibiotic therapy and the pneumonitis completely cleared by May 21, 1953. On May 24, 1953, a barium swallow with a small amount of thin solution revealed a tracheoesophageal fistula. The patient was bronchoscoped and what appeared to be a large fistula without any granulating surfaces was seen at the origin of the left main bronchus.

As the patient appeared at this time to be in fairly satisfactory condition, we decided to proceed with repair of the defect. The fistula was exposed through the bed of the right fourth rib. It was freed up and closed as shown in Fig. 3. There was considerable inflammatory reaction around the fistula and, as shown, there was an ulceration which could not be freed from the arch of the aorta. We finally achieved what was thought to be a satisfactory closure.

During the first postoperative twenty-four hours, the patient coughed up a great amount of mucus. On the next day he improved enough so that we removed the Levine tube, although feedings were not started. On the third postoperative day he suddenly began coughing up bile-stained fluid, which also drained from the thoracostomy tube. The right lung collapsed completely and an extensive pneumonitis developed on the left side. Tracheotomy was done and several transfusions were given. A Levine tube could not be made to pass through the esophagus and the patient was far too ill to risk esophagoscopy. He became rapidly moribund and expired on June 3, 1953. Autopsy showed complete disruption of both suture lines together with atelectasis of the right lung and an extensive chemical pneumonitis of the left lung.

TABLE I. ETIOLOGY: 84 REPORTED CASES OF ESOPHAGOTRACHEOBRONCHIAL FISTULA*

Traumatic	25
Undetermined	18
Tuberculosis	14
Diverticulum of esophagus	12
Syphilis	11
Broncholiths (?)	2
Empyema	1
Actinomycosis	1

*Includes authors' two cases.

TABLE II. ETIOLOGY: 25 REPORTED CASES OF TRAUMATIC ESOPHAGOTRACHEOBRONCHIAL FISTULA

Nonpenetrating wound	6
Foreign body	4
Dilation of stricture	4
Chemical (lye)	2
Penetrating wound	2
Operative	2
Extrapleural Lucite plombage	1
Incomplete data	4

TABLE III. SURGICAL TREATMENT IN 31 REPORTED CASES OF ESOPHAGOTRACHEOBRONCHIAL FISTULA

TREATMENT	NO. CASES	RESULTS		
		CURED	UNCHANGED	DIED
1. Cauterization (endoscopic)*				
A. Chemical	5	4	1	0
B. Electric	1	0	1	0
Total	6	4	2	0
2. Direct surgical repair				
A. With preliminary gastrostomy	4	4	0	0
B. Without preliminary gastrostomy†	10	7	0	3
Total	14	11	0	3
3. Pulmonary resection and closure of defect	5	4	0	1
4. Palliative gastrostomy	3	0	2	1
5. Drainage coexisting lung abscess	2	2	0	0
6. Jejunal loop bypass (lye stricture of distal esophagus)	1	1	0	0
Over-all total	31	22	4	5

*All small fistulas.
†Includes authors' cases.

COMMENT

The first case is of interest in that it demonstrates that nonpenetrating trauma can cause an esophagotracheal fistula, the clinical appearance of which

may be delayed several days. Stevens[5] reported a similar case. The previous observation[3, 4] that feedings placed in the stomach are not well tolerated by these patients was confirmed. Partial feedings were possible with the tube placed well beyond the pylorus, although the feeding had to be given very slowly, lest regurgitation occur.

Several lessons were learned from the second patient: First, the presence of ulceration at the fistula site should have contraindicated surgery, had it been recognized preoperatively. This failure argues for a most meticulous endoscopic examination of the fistula from both sides, preferably with optical equipment. Second, the vigorous postoperative coughing exhibited by this patient was, in our opinion, at least partially responsible for the disruption of the suture lines. Since tracheotomy is helpful in obtaining healing after other tracheal repairs, it would seem properly indicated in a case such as this, particularly since it prevents a high air pressure from being exerted upon the suture line. Third, although tube feedings were retained fairly well by this patient, it is felt that in view of the rather debilitating illness, preliminary jejunostomy might have been preferable. Vigorous preoperative alimentation might have influenced the outcome. Removal of the Levine tube was followed quickly by desire to have it back in place at a time when it was impossible to replace it, suggesting that all should be well for several days before abandonment of gastric decompression. As to etiology, Case 2 was classified as undetermined, as the infection present on admission could not be definitely implicated as the cause of fistula.

The surgical approach through the bed of the fourth rib gave excellent exposure in both cases and permitted the fistulas to be easily mobilized. Closure of the defects was effected without great difficulty and respiration was maintained by passing the intratracheal tube beyond the defect (Fig. 2).

SUMMARY

1. Nine new cases, including two of ours, are added to the seventy-five collected cases of esophagotracheobronchial fistula previously reported by Coleman and Bunch.

2. Two case reports are given together with a discussion of the significant features of each.

3. The factors responsible for the unsuccessful outcome in the second case are discussed.

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A SIMPLIFIED THORACIC SUCTION UNIT

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FOLLOWING thoracic surgery it is often desirable to apply negative pressure to the pleural cavity. Commonly this is done by the use of a small suction pump and two large glass jars; one of the jars is used to collect the fluid from the chest, while the other, through the use of an underwater escape tube, is used as a regulating valve. By varying the length of the escape tube submersed the amount of suction applied is regulated. Such an arrangement is excellent as far as functioning and safety go, but is very cumbersome, difficult to transport, and often loses water through the escape tube when the patient, by coughing, builds up the air pressure to a point higher than the pump can accommodate.

Fig. 1.—Pump unit; see text for description.

Recently a new nasogastric type suction unit, containing a pump, gauge, regulating valve, and collecting bottle, all in a small metal case that weighs only 10 pounds, has become available (Fig. 1).* It has been used to provide thoracic

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*The unit described is the Burdick SA-1 McLellan Suction Unit manufactured by The Burdick Company, Milton, Wis.

cavity suction with very satisfactory results. Other advantages, besides its completeness, compactness, and lightness in weight, are: 1. The gauge is in the system at all times, so that the amount of negative pressure being applied registers constantly. 2. There is a safety float in the collecting jug, which automatically prevents fluid from reaching the gauge or pump. 3. The regulating mechanism is so constructed that the desired amount of suction can be set prior to connecting the pump to the drainage tube. 4. The collecting container can be emptied without disconnecting the tubing.

Three minor disadvantages are present in the unit. They are: 1. The gauge is calibrated in mercury instead of water. 2. It is difficult to visualize the fluid in the collecting jar. 3. The jar is not calibrated. However, the manufacturer, on being informed of these faults, immediately rectified them. The newer models will have: (1) the gauge calibrated in both centimeters of water and millimeters of mercury, (2) the metal case will have multiple fenestrations to allow better visualization of the collected fluid, and (3) the container will be calibrated in ounces and cubic centimeters.

SUMMARY

A lightweight, easily portable suction unit that is suitable for postoperative thoracic suction is described.

PULMONARY TORULOSIS COMPLICATING PULMONARY TUBERCULOSIS TREATED BY RESECTION

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A REVIEW of the literature[1-18] has failed to disclose living patients with tuberculosis combined with torulosis; the appearance of a case is of sufficient interest to deserve mention. Stoddard and Cutler,[19] in 1916, were the first to describe accurately the clinical and pathologic characteristics of torular infection in man. Following the work of these observers, the disease received more general recognition and cases were reported from practically all parts of the world.

In 1931, Freeman[20] published a comprehensive monograph on the subject and at that time was able to collect forty-three cases of torular infection from the literature. In 1937, Taber[15] stated that to date there had been less than sixty cases of torular infection in man reported in the entire world. He also stated that the symptoms were varied depending upon the part of the body which was attacked, but they always delayed in appearance because of the insidious onset of the condition.

In the lungs, the roentgenogram may suggest inflammatory disease or neoplasm. A cough develops with little or no fever or few if any night sweats; there is some pain in the chest, malaise, and loss of weight. In 1951, Cook[21] reviewed the literature and found two hundred cases of torula reported to date. Of this number, only five cases of solitary lung involvement were recorded. In 1952, Berk and Gerstl[22] reported a case of solitary pulmonary torulosis simulating tumor in which a lobectomy was done. They also reported the five other cases found in the literature as reported by Cook. Baker,[23] in 1952, reported three patients with pulmonary cryptococcosis that had round, solid lesions varying in size from that of a plum to that of an orange. All three patients underwent resection and were alive nine months, nine and one-half months, and four years after operation. These three cases would seem to indicate that the resection of pulmonary cryptococcosis (torulosis) is effective. Perhaps resection was prophylaxis against the development of cryptococcosis of the central nervous system. Froio and Bailey[24] reported a case of cryptococcosis of the lung cured by lobectomy; the patient was alive seven years following surgery.

CASE REPORT

First Admission.—J. R. W. was a 19-year-old married white man; he was first admitted to Battey State Hospital on Jan. 15, 1951. The diagnosis was pulmonary tuberculosis, moderately advanced (Fig. 1). The patient gave a history of having an acute illness in August, 1950, which was diagnosed as virus pneumonia. Following this he had had moderately severe fatigue, which lasted without apparent change until Oct. 7, 1950. At the onset

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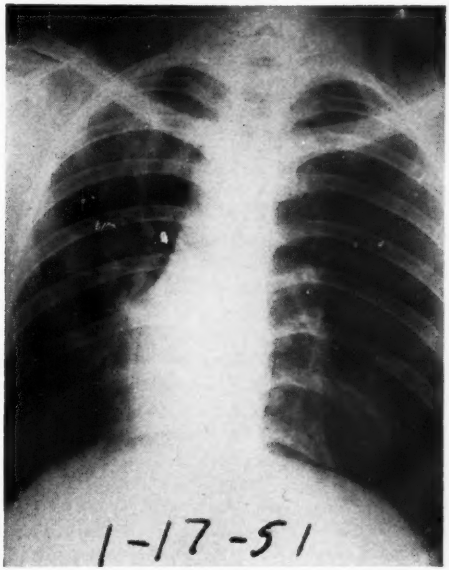

Fig. 1.—Admission roentgenogram taken Jan. 17, 1951.

Fig. 2.—X-ray picture taken Sept. 20, 1951. Improvement on bed rest, antibiotics, and pneumoperitoneum is shown.

of illness he had bloody expectoration on two successive mornings. He had never had any previous sputum production or cough. He was hospitalized for five days in October, during which time an x-ray film was taken; the report indicated that a diagnosis pulmonary tuberculosis was suspected.

A survey x-ray examination in 1948 was reported negative. Sputum examination on Oct. 8, 1950, was reported as positive for acid-fast bacilli. The patient had lost eight pounds over the three-month period, from August to October, 1950.

The patient's only known exposure to tuberculosis occurred in 1948; at that time he had been exposed to a fellow worker in a shoe factory for three months before the other worker was discovered to have pulmonary tuberculosis.

Physical examination was complete and noncontributory.

An admission x-ray film dated Jan. 17, 1951, was interpreted as follows: "No definite infiltration is recognized in the right lung, although rather heavy markings are at and near the second interspace. The left lung shows dense and moderately dense, soft, scattered shadows of infiltration from the apex to the fourth interspace. Classification: The appearance is that of moderately advanced pulmonary tuberculosis."

The laboratory work was noncontributory except for one positive direct smear on Feb. 2, 1951. Subsequent cultures were positive for typical, acid-fast organisms on three occasions. Tuberculin test was 1 plus to 0.01 mg. of old tuberculin.

A bronchoscopy on Feb. 2, 1951, showed the right side to be negative. The left upper lobe orifice was somewhat redder than the remainder of the bronchial mucosa, although there was no edema, ulceration, or tubercle formation. The mucosa did not bleed upon manipulation and the bronchus showed no degree of stenosis. The remainder of the left side was within normal limits and the impression of the bronchoscopist was that this was probably a low-grade tuberculous endobronchitis.

This patient was started on a course of streptomycin (1 Gm. every third day) and PAS (10 Gm. daily) for a period of six months on Feb. 3, 1951. Pneumoperitoneum was instituted on Feb. 6, 1951.

During the ensuing nine months this patient showed progressive roentgenologic improvement of the disease with bed rest, antibiotic therapy, and pneumoperitoneum.

He gained eight pounds and was asymptomatic; the sputum converted. On Oct. 9, 1951, this patient signed out against medical advice and left the hospital (Fig. 2).

Interval History.—The patient stated that after leaving the hospital in October, 1951, he returned home where he continued to spend about sixteen hours out of each twenty-four in bed. He received pneumoperitoneum refills once each week, receiving 900 c.c. of air at each refill. He denied any illnss or accident after returning home. He had had an x-ray examination of his chest every three months since going home. The sputum was reported negative in February, 1951. X-ray examination of the chest revealed a change, and, for that reason, sanatorium admission was again sought for this patient.

Second Admission.—This 21-year-old patient was again admitted on June 12, 1952. Fig. 3 shows the change that had taken place in the disease while at home.

Physical examination was again noncontributory.

Laboratory work was entirely negative including repeated sputum examinations which were consistently negative for acid-fast bacilli, including animal inoculations and cultures of gastric contents.

A diagnostic bronchoscopy of Aug. 4, 1952, was negative as was a bronchogram.

On Aug. 4, 1952, this patient was seen in surgical conference. The 3 cm. mass located in the second anterior interspace on the left side was believed to be an area of fibrocaseous tuberculosis. Roentgenologically, it was thought to be located in the superior division of the left lower lobe.

Since admission on June 12, 1952, he had been negative to direct smear, culture, and animal inoculation for acid-fast bacilli. He was accepted for surgical excision of the tuberculoma.

Fig. 3.—Roentgenogram showing change that occurred since Sept. 20, 1951.

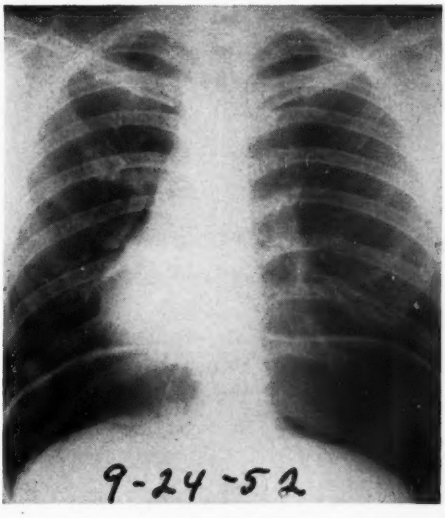

Fig. 4.—Roentgenogram showing excavation of previously solid lesion.

Because of a long waiting list this patient was not transferred to the surgical service for the contemplated surgery until March 11, 1953. In the meantime it can be seen that the solid lesion had excavated.

In spite of the solid lesion excavating and becoming a cavitary lesion, the sputum cultures of Nov. 10, 1952, and Jan. 21, 1953, were negative to direct smear and culture for acid-fast organisms. The significance of this was not fully appreciated and no further studies were done at that time.

On March 24, 1953, this patient had an exploratory thoracotomy on the left side. No free fluid was encountered. There were seven relatively lengthy and avascular adhesions binding the apical posterior segment of the left upper lobe to the parietal pleura, as well as

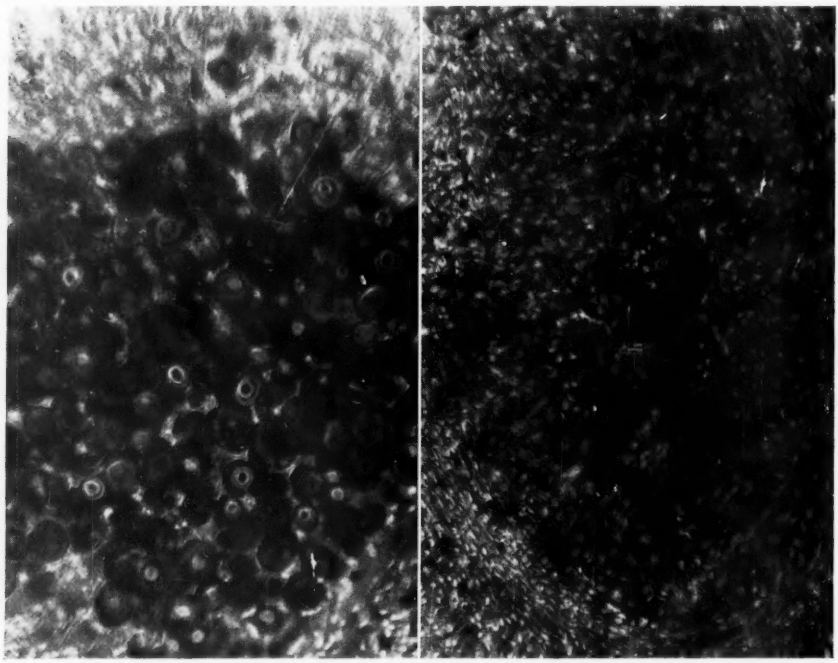

Fig. 5.—Photomicrographs showing torulosis.

a few adhesions going up to the cupula. A complete fissure line was present. By inspection and palpation, the left upper lobe revealed no appreciable evidence of induration or nodular formation. There was a definite circumscribed, 2 cm. mass in the superior segment of the left lower lobe. Elsewhere the lung was free from palpable or visible lesions. A subsegmental type of resection was carried out.

The preoperative diagnosis was pulmonary tuberculosis and we still felt, postoperatively, that this was a tuberculous lesion.

Pathology.—

The gross description is as follows:*

"Received is one small, round, nodular sub-segment of the superior division, left lower lobe, measuring 2 x 1½ x 1½ centimeters and weighing 2½ grams. The external surface is circumferentially roughened and reveals brownish-red parenchyma without pleura. On

*Given by Dr. Ingrid Stergus, Pathologist at Battey State Hospital.

section it is greatly replaced by somewhat gelatinous appearing, dirty, yellowish-grey, inspissated debris which appears to have a lamellar arrangement. This central portion measures one-half centimeter in diameter and is surrounded by poorly demarcated lesions, which are numerous, small and indurated. They are greyish-brown and vary from 0.1 to 0.2 centimeters in diameter. Direct smears and cultures from the ground up material were negative for acid fast bacilli. Cultures from the same material were negative for fungi.''

Microscopic Description.—Sections revealed a chronic fibrosing pneumonitis, nonspecific in appearance, with foci of patchy interstitial, as well as peribronchial, mononuclear cellular infiltrate and scattered giant cells of foreign body type showing centrally piled nuclei. No Langhans giant cells were observed except one in one tubercle-like structure. There were very occasional small granulomatous structures composed of epithelioid cells lacking any central necrosis. The most conspicuous findings in these sections were numerous aggregates of rather large spherical- to oval-shaped, pale blue-staining, yeastlike organisms showing an occasional single budding.

The organisms were surrounded by bloated empty spaces representing their gelatinous capsules which did not take up the hematoxylin and eosin stain. Aggregates of these organisms were found in groups, either free in the interstitium or in fair numbers within foreign body giant cells. In one area they were found in the central portion of a small pseudotubercle, and a few of them were present within the rather scant and collapsed alveolar lumina and bronchioles.

Definite necrosis was scant and intermingled with a few cholesterol deposits and organisms showing bloated capsules. Some of the quite numerous capillaries revealed endothelial proliferation. There were no noteworthy changes of the large vessels. The bronchial mucosa, for the most part, was well preserved. No lymph nodes were seen in any of the serial sections.

Diagnosis.—The diagnosis was cryptococcosis infection with chronic pneumonitis of the subsegment of the superior division, left lower lobe.*

Postoperative Course.—The postoperative course of this patient was benign. Roentgenologically, there was some postoperative reaction surrounding the area of subsegmental resection which subsequently cleared markedly, although a small residue can still be seen in this same area.

Postoperatively, the sputum has remained negative to direct smear and culture for acid-fast bacilli.

A postoperative bronchoscopy on June 1, 1953, was essentially negative. Cultures from bronchial washings revealed *Candida albicans;* no cryptococcosis was isolated.

This patient was placed on streptomycin and PAS just prior to surgery, since it was believed that this was a tuberculous lesion, and with the recommendation that it be continued until Sept. 10, 1953.

SUMMARY

This is a case of proved pulmonary tuberculosis, treated with streptomycin and PAS with resolution of the exudative disease. The patient re-entered the hospital because of x-ray changes suggesting a tuberculoma. This round area of disease excavated and yet the patient's sputum remained negative.

Because of the fact that the patient had had a proved attack of tuberculosis our index of suspicion was not high enough to run fungus sputum studies on this patient, although he was negative with an open cavity and on no antibiotic therapy. Surgical excision and subsequent microscopic slides of the excised tissue proved that this was cryptococcosis. In the slides there are areas suggestive but not diagnostic of tuberculosis. All cultures from the resected specimen were negative for tuberculosis.

*Seen in consultation by Dr. Libero Ajello, Mycologist, Communicable Disease Center, Chamblee, Ga.

This is the only instance we have been able to find, after an extensive review of the literature, showing cryptococcosis and pulmonary tuberculosis in a living patient, who had either or both of the lesions treated surgically.

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CONGENITAL CYSTIC LUNG

Successful Pneumonectomy in a 3-Week-Old Baby

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SOME congenital cysts of the lung may only be discovered accidentally during a routine examination of the chest. However, there are two sorts of complications which may give rise to trouble in congenital cystic lung.

In the first place infection of the cyst may occur and this may be fatal; second, due to a ball-valve action, very high positive pressure may be built up within the cyst so that it becomes greatly distended, compressing the adjacent lung tissue and displacing the mediastinal organs to the opposite side of the chest. Unless prompt treatment is carried out to relieve the respiratory distress, a fatal result may ensue.

In the case reported here, congenital cystic lung in a 10-day-old baby did indeed give rise to great respiratory distress which did not react to simple measures like the needling of the cyst cavity. Eventually, when the baby was 23 days old, a left pneumonectomy had to be carried out.

CASE REPORT

M. R. was admitted to hospital on April 18, 1952; she was 15 days old with a history of being cyanotic and dyspneic for three days. On examination the child was dyspneic and was cyanotic. Temperature was normal, pulse was 160, and respirations were 54. The heart was located to the right of the lower end of the sternum and there did not appear to be any air entry on the left side of the chest. X-ray films of the chest showed that there were numerous cysts in the left lung and the heart was displaced to the right (Fig. 1).

Needling of a larger cyst was carried out, and this cyst was shown to have a positive pressure of 15 cm. when measured with an artificial pneumothorax apparatus. An underwater drainage system was connected to a pneumothorax needle. The patient was treated by the pediatrician with repeated needling and underwater drainage until I was asked to see her on April 26, 1952.

It was obvious that the needling was resulting only in a temporary improvement and so on April 26, 1952, a thoracotomy was carried out through the bed of the fifth left rib when the child was 23 days old. On opening the pleura the upper lobe was found to contain a very large cyst which was filled with air and appeared to have a large communication with the bronchus. The lower lobe also contained several fairly large cysts. An upper lobectomy was carried out, but after this procedure, when the anesthetist attempted to inflate the lower lobe, it was found that that lobe would not inflate. In view of this fact and because it was felt that the cysts in the lower lobe would almost certainly give rise to trouble at a later date, the operation was converted into a left total pneumonectomy. The pleural cavity was drained by a 5 c.c. Foley catheter. During the operation and during the postoperative period, the child had 450 c.c. of Hartmann solution and about 50 c.c. of blood. She was given, after the operation, streptomycin (70 mg. twice a day) and a course of Chloromycetin.

She made a satisfactory recovery after operation but the convalescence was complicated by discharge from the stab wound which persisted for about six months before it finally cleared up. The wound has now been dry for two months.

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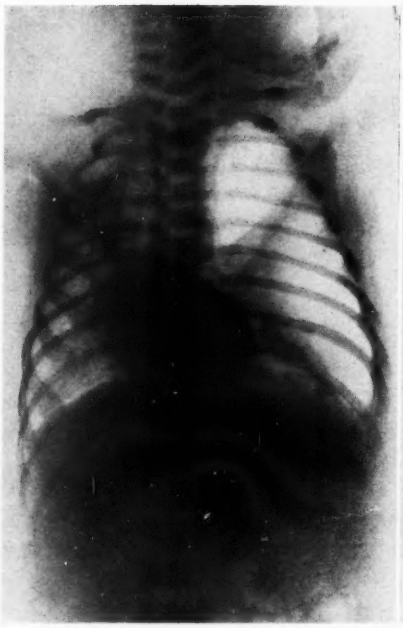

Fig. 1.

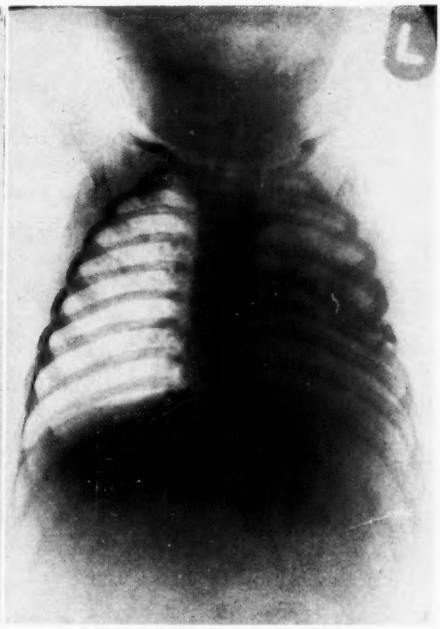

Fig. 2.

Fig. 1.—X-ray film shows numerous cysts in the left lung and displacement of the heart to the right.

Fig. 2.—X-ray picture taken eleven months after operation showing that the heart is not now displaced to the right.

Fig. 3.—Photograph showing appearance of child at the age of 11 months.

Eleven months following operation the child's condition was very good (Fig. 3). She eats normally; weight is normal for a child of her age. There is no deformity of the thoracic cage and there is no scoliosis of the spine present. X-ray films now show no displacement of the heart shadow (Fig. 2).

The pathologic report on the lung was that both lobes showed small thin-walled multiple cysts varying from 1 mm. to about 5 mm. in diameter. The cysts were more numerous at the periphery than at the center of the lobes. One or two large, thin-walled cysts lying immediately below the visceral pleura had already ruptured. The cysts were lined with cuboidal, columnar, and ciliated epithelium and they appeared to communicate with the bronchi. This would appear to be a case of congenital cystic disease of the lung.

The youngest patient to date to have a pulmonary resection was a 15-day-old baby, who was treated by Burnett and Caswell. This child was admitted to hospital with marked dyspnea. X-ray examination showed multiple loculations of air in the left side of the chest which appeared to involve the entire hemothorax and displace the mediastinum markedly to the right. The child was diagnosed as having a congenital left diaphragmatic hernia, and when she was 14 days old laparotomy was performed. At operation it was found that both diaphragms were intact; it was then realized that the child was suffering from congenital cystic disease of the left lung. The next day thoracotomy was performed; the left upper lobe was normal, and she was, therefore, treated by left lower lobectomy.

Gross, in December, 1944, carried out a left pneumonectomy in a 23-day-old baby for congenital cystic disease. The remarkable ease with which lobectomy and pneumonectomy can be done in infants was noted again in this patient. It has previously been described by Fischer and his co-workers, by Gross, and by Burnett and Caswell. Dissection of the structures in the hilum is remarkably simple and can be rapidly carried out.

My thanks are due to Dr. J. G. Dathan for referring this case to me, to Dr. C. Hayes for the anesthesia, to Dr. C. Giles for the pathologic report, and to Dr. J. White for the x-ray photographs.

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BLOOD LOSS AND ITS REPLACEMENT IN THORACIC SURGERY

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THE large blood loss that accompanies major surgery of the chest is obvious to all observers of such operations. In fact, the present state of development of thoracic surgical techniques would not be possible without the availability of adequate amounts of blood for infusion. The amount of blood given during the course of surgery is usually based upon estimates of blood loss by the surgeon and the anesthetist, derived from evaluation of the condition of the patient and observation of discarded sponges.

That such methods are open to wide individual variations can be shown by the wide divergence of estimates of total blood loss given by individual members of an operating team. Such a significant variation in the estimated blood loss led us at the West Tennessee Tuberculosis Hospital to adopt the sponge weight method of measuring blood loss as described by Gross[1] and by Johnson and Kirby,[2] among others. The dry sponges were weighed in sufficient number to obtain an average weight for one sponge, although the range was small. At operation the sponges are weighed on a dietetic scale as they are discarded, the dry weight subtracted, and the remainder counted as blood, assuming that 1 Gm. equals 1 c.c. of blood. Saline for irrigation is used in measured quantities, and the amount used is subtracted from the volume of the contents of the suction bottle. Wet pads are not used. Finally, an estimated volume is added to the total to account for the blood on the drape sheets.

Although this technique is admittedly not accurate enough for exact experimental measurements of blood loss, it is simple and rapid and is not subject to gross error. The circulating nurse can add this task to her duties without difficulty. A running tally of the blood loss is kept and the blood is replaced as it is lost. The amount of blood given in the postoperative period is governed by the amount and quality of drainage and the condition of the patient.

METHODS AND MATERIALS

For the purpose of this study, every major thoracic surgical procedure done at the West Tennessee Tuberculosis Hospital between Jan. 1, 1952, and April 30, 1953, has been reviewed. The type of procedure, the amount of blood administered, and the occurrence of surgical shock and mortality have been noted. A total of 412 consecutive procedures is included. In 196 of these

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the blood loss was measured by the sponge weight method previously outlined. In 216 the blood loss was estimated and replaced as considered necessary in the operating room and in the immediate postoperative period.

A few operations are not included such as the revision of chest wall sinuses and thoracotomy drainage procedures. In the 412 operations, there has been one death. This occurred five days after a first-stage thoracoplasty done over a pneumonectomy space. The patient, an obese Negro man 44 years old, was in respiratory distress from the time of surgery and died on the fifth day. A widespread disseminated tuberculosis was present, together with an unsuspected cor pulmonale. One death occurred twelve hours after completion of a pneumonectomy. About one hour after surgery the patient suddenly went into profound shock and developed massive interstitial emphysema. Intercostal drainage was instituted, blood in large quantities was removed and transfusions started in three veins. The blood pressure responded promptly, but the patient lapsed into coma. Convulsions occurred and death followed in eight hours. Autopsy could not be obtained, but it is speculated that some cerebral embolic episode must have occurred. This case is not included in the analysis, because as the blood was given some was spilled; moreover, some blood was strained and given back after aspiration from the chest. The figures are valueless.

Two patients who had lobectomy are also excluded since both had postoperative bleeding requiring secondary surgery. One of these patients received nineteen transfusions (9,000 c.c. of blood) in the forty-eight hours during and immediately after surgery, and the other patient received twelve transfusions (5,750 c.c.). Both patients recovered. It was decided that these two cases would unduly distort the average figures.

One patient who had decortication of an old tuberculous empyema received a total of 7,500 c.c. of blood. He finally succumbed to repeated exsanguinating episodes, apparently related to operative injury of mediastinal vessels.

With these exceptions the operations analyzed here include all cases done on the surgical service at the West Tennessee Tuberculosis Hospital during the sixteen months ending April 30, 1953. There is considerable overlapping in the series, since the sponge weighing at first was somewhat irregular, being done only on specific request of the operating surgeon. A total of ten different surgeons, both residents and staff surgeons, operated on the service during the period under discussion.

In Table I, the 196 operations are listed in which blood loss was calculated by the sponge weight method. There are 90 thoracoplasty procedures of three stages. Some of the first- and second-stage procedures were done after pulmonary resections, while others were primary thoracoplasties, either of the Alexander type or similarly staged operations. In all three procedures, approximately 300 c.c. appears to be the minimum blood loss by our technique. The maximum is extremely variable.

TABLE I. BLOOD LOSS IN CERTAIN THORACIC OPERATIONS AS MEASURED BY SPONGE WEIGHT METHOD

OPERATIVE PROCEDURE	NO. OF CASES	BLOOD LOSS RANGE IN C.C.	BLOOD LOSS AVERAGE
Thoracoplasty, Stage I	55	335-1,708	932
Thoracoplasty, Stage II	23	329-1,360	788
Thoracoplasty, Stage III	12	300- 900	556
Pneumonectomy	17	400-2,930	1,051
Lobectomy	43	329-3,066	1,153
Segmental resection	19	360-1,430	814
Lobe and segment decortication, lobe and decortication	20	899-2,403	1,340
Miscellaneous	7	325-2,000	752

The remaining 106 procedures were intrapleural operations of varying magnitude. Those included under the heading "Miscellaneous" are three pulmonary biopsies, a mediastinal cyst, two exploratory operations in which inoperable carcinoma was encountered, and one aortic aneurysm packed with wire. The minimum operative blood loss is around 325 c.c., while the maximum ranges up to 3,066 in one particularly difficult extrapleural lobectomy. Again in all these procedures the wide variation among cases is noteworthy. There is such a range that figures for average loss are meaningless.

In Table II there is a clinical comparison between the 196 operations in which sponges were weighed, and the 216 instances in which replacement was based on estimates of blood loss and evaluation of the condition of the patients. The eleven operations under "Miscellaneous" include three pulmonary biopsies, three exploratory operations for carcinoma, three extrapleural pneumonolysis, and one operation for funnel chest. Systolic blood pressure below 90 mm. Hg for more than thirty minutes at any time during operation or in the postoperative period was defined as shock. In second-stage thoracoplasty operations, the amount of blood given was significantly greater in operations in the weight loss column and the percentage of surgical shock somewhat higher. In first- and third-stage thoracoplasty operations, the amount of transfusions used was essentially the same for the two groups, while shock was much more frequent in the patients in whom blood loss was not weighed.

TABLE II. CLINICAL COMPARISON BETWEEN OPERATIONS WITH BLOOD LOSS WEIGHED AND ESTIMATED

	BLOOD LOSS WEIGHED				BLOOD LESS ESTIMATED			
		BLOOD GIVEN	SHOCK			BLOOD GIVEN	SHOCK	
OPERATIVE PROCEDURES	NO.	AVERAGE	NO.	%	NO.	AVERAGE	NO.	%
Thoracoplasty, Stage I	55	1,001	3	5.4	62	1,027	16	26.0
Thoracoplasty, Stage II	23	817	3	13.0	26	574	2	7.7
Thoracoplasty, Stage III	12	658	0	0	16	550	1	6.0
Pneumonectomy	17	1,735	0	0	20	1,813	6	30.0
Lobectomy	43	1,682	6	14.0	52	1,889	12	23.0
Segmental resection	19	1,097	0	0	14	1,525	2	14.0
Lobe and segment decortication, decortication and lobe	20	1,691	0	0	15	1,653	1	7.0
Miscellaneous	7	1,000	0	0	11	590	0	0

For intrapleural operations, the amount of blood given was comparable in the two groups except in segmental resections. In these cases more blood was used in the "nonweighed" group and two instances of shock were recorded. However, the number involved is too small to be significant.

Table III is a summary of the cases divided into larger groups, which may possibly be of more significance. For both thoracoplasty and other procedures, shock is approximately three times as common in the nonweighed than in the weighed group.

TABLE III. SUMMARY

	THORACOPLASTY PROCEDURES		OTHER OPERATIONS		TOTAL	
	CASES	SHOCK	CASES	SHOCK	CASES	SHOCK
Weighed	90	6— 6.7%	106	6— 5.7%	196	12— 6.0%
Nonweighed	104	19—18.3%	112	21—18.7%	216	40—18.5%

DISCUSSION

The clinical management of the cases presented here has been carried out by the members of the staff of the hospital, in both medical and surgical departments, and has been uniform throughout the period under discussion. The operative technique has not appreciably changed, and the operations have been performed by the same members of the surgical staff and by residents under their direction. The only difference in the care of the patients has been the addition of the sponge weight method of blood loss determination and a more careful attention to blood replacement at the time it is lost. For these patients, the measurement of blood loss has been of value. It may be that the emphasis on blood loss has resulted in more adequate hemostasis and that the patients have actually lost less blood than those in whom definite figures for blood loss are not obtained. Over such a long time and with so many surgeons involved, this does not seem likely. Emphasis is constantly placed on the importance of keeping up with the blood loss. The patient returns to his room with his circulating fluid in balance. Much less blood is needed to prevent shock than to treat it after the blood pressure has fallen to low levels.

In the 412 operations catalogued here, the total blood used amounted to 516,750 c.c., the equivalent of 1,033 transfusions of 500 c.c. each. This blood was used in sixteen months on one thoracic surgical service. The figure does not include transfusions administered preoperatively or those used on the medical services of the hospital. There are also a few operations not included. It is re-emphasized that an active chest surgery service depends, to a great extent, on an adequate blood bank.

SUMMARY

A study of blood loss and its replacement during operations on the chest has been presented, with 412 major surgical procedures included in the statistical analysis. The method of measurement as outlined seems accurate enough for practical purposes and has the virtues of simplicity and economy. The ad-

vantages of measuring and replacing blood loss as it occurs is borne out statistically and measured by a significantly decreased incidence of surgical shock in the group of patients in whom this was practiced. Hemostasis is constantly emphasized to the operating surgeons by the periodic announcement of weighed blood loss.

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THE PROBLEM OF THE FAR-ADVANCED MALIGNANCY IN THE UPPER ESOPHAGUS

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CARCINOMA of the upper esophagus continues as a formidable scourge and remains a challenge to the physician, but offers a very poor prognosis to the patient. The articulate exponents of radical deviscerating surgery, in popularizing their technique for this or any far-advanced malignancy, often leave in their wake a host of problems. The surgeon attempting to emulate these venerable scientists frequently finds himself beset with discouraging and alarming results. The high operative mortality, the few survivors at the end of a year, and the marked disturbance in digestive physiology are sufficient reasons for a closer inquiry and evaluation into the philosophy of extreme and radical surgery in carcinoma of the upper esophagus.

In any form of therapy the benefits accruing from its use must be weighed against its mortality and morbidity. While in our small series of nineteen cases, there were no anesthetic deaths, and only one operative death, the literature is, nevertheless, replete with them. What is more important is the fact that in our series, no patient survived more than sixteen months, and a similar picture has been observed in practically all clinics.

These individuals with upper esophageal malignancy primarily seek relief from their inability to swallow. This extreme difficulty, coupled with an urgent desire to eat, provokes them into undergoing almost any type of surgery for relief. After enduring a most difficult, trying, and serious operation, the patient finds himself able to swallow food, but without any desire to eat. Food becomes tasteless, and its ingestion is frequently associated with substernal spasm or regurgitation. Does an end result producing such an unhappy physiologic cripple warrant the extensive deviscerating surgery?

In view of the dubious symptomatic relief and seeming incurability of this lesion, it is incumbent upon the surgeon to advise the patient or his family relative to the type of surgery indicated. The more malignancy of the esophagus is observed the greater becomes the desire of the surgeon simply to relieve the symptoms and resort to radical surgery only in ideal cases where a chance for cure is reasonably good. Thus, radical resection of the esophagus should be undertaken in early localized lesions, and palliative procedures employed where the lesion is fixed to adjacent organs or where wide lymphogenous spread is evident.

However, the discovery of early malignant esophageal lesions at present is truly a rarity and usually due to fortuitous circumstances. This is demonstrated in the review of our case histories; symptoms have been present from three months to two years, with many of the patients unable to swallow both solid

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and liquid foods. Thus, the average patient coming to the surgeon had moderate to far-advanced carcinoma of the upper esophagus, which on occasions was solidly fixed to the aorta, lymph nodes, bronchi, and other mediastinal organs. Our present approach, therefore, is an inadequate one for the eliciting of early lesions.

The medical profession would do well to be on the alert and support any new adequate screening test which may be developed for malignancy. Until such a screening test is developed, accidental discovery will be our only source for detecting small localized lesions which ordinarily provide us with five-year cures. At the same time, both the layman and the physician should appreciate their responsibility, for frequently either one or the other has neglected to determine the cause of a progressive dysphagia. Certainly any individual with a difficulty in swallowing deserves roentgenoscopic investigation by a competent radiologist. If this simple procedure were accomplished, many early lesions of the esophagus might be detected, and a reasonable percentage of cures might be expected. Even though the malignancy may be far advanced or incurable, the patient deserves the right to have relief from his symptoms, if possible, in the least hazardous manner.

The patient's symptoms may be controlled in several ways. If a patient is unwilling to undergo a major surgical ordeal, or the lesion is extremely far advanced, the patient can be offered a gastrostomy, the use of a small polyethylene tube, or roentgen-ray therapy. The gastrostomy is mentioned only for the purpose of the strongest condemnation, since it leaves the patient in a ghastly state and existence is intolerable. The insertion of a polyethylene tube introduced through the nose into the stomach may sustain a patient for months. On occasion, the preliminary swallowing of a string may facilitate the introduction of the polyethylene tubing. Interestingly enough, with the tube in place, the swallowing mechanism seems to improve. This may be due to the necrosis caused by the pressure from the tube on the tumor. When improvement in swallowing is real the tube may be removed for varying periods of time until there is a recurrence of dysphagia, requiring its insertion again. I should like to emphasize that roentgen-ray therapy surprisingly often provides temporary relief in carcinoma of the upper esophagus. This is in sharp contrast to lesions at the lower end, where little or no benefit is derived from this form of treatment.

In cases in which neoplasm is localized, exploratory thoracotomy offers the best hope for the control of the lesion or symptoms. The surgeon can resect the diseased portion of the esophagus and perform an esophagogastrostomy. However, in far-advanced lesions, when hope for a cure cannot be anticipated, a short-circuiting operation with the cancerous portion left intact and the stomach anastomosed to the esophagus proximal to the lesion may be preferable. While no cure is anticipated with this procedure, the patient can eat and remain relatively comfortable until the terminal period.

It was elected to do this in four cases which were far advanced, and in which the average survival time was eleven months. Our surgical approach to the malignancy was through an extended incision in the right anterior third

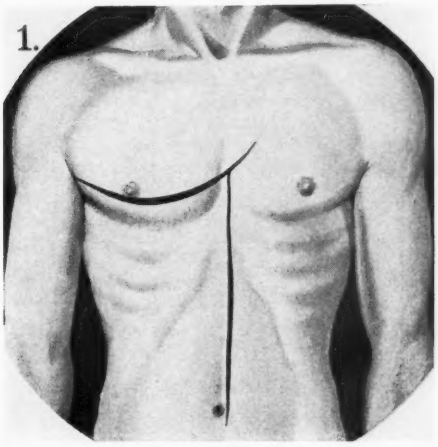

Fig. 1.—A curved incision is made beginning at the left third costal cartilage extending beneath the nipple to the posterior axillary line. By using a curved incision, the flap can be reflected so the second, third, and fourth costal cartilages can be easily exposed and severed if necessary for a better exposure. The midline incision is continued down the sternum and linea alba to the umbilicus. The diaphragm is cut in line with the incision to the esophageal hiatus.

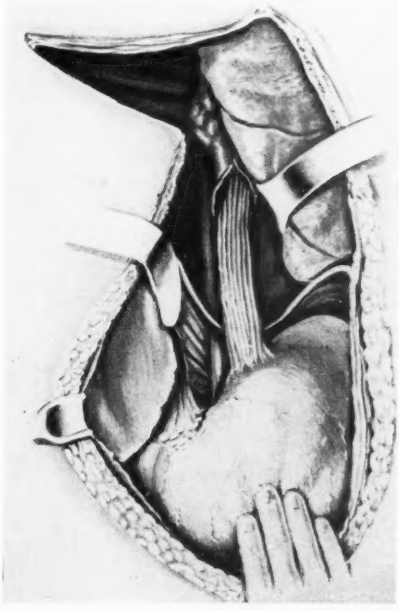

Fig. 2.—This shows the lung and heart retracted to the left exposing an extensive esophageal malignancy which has invaded the surounding tissue. The esophagus distal to the lesion and the stomach have been freed of their vascular attachment, preparatory to delivering the stomach into the chest cavity.

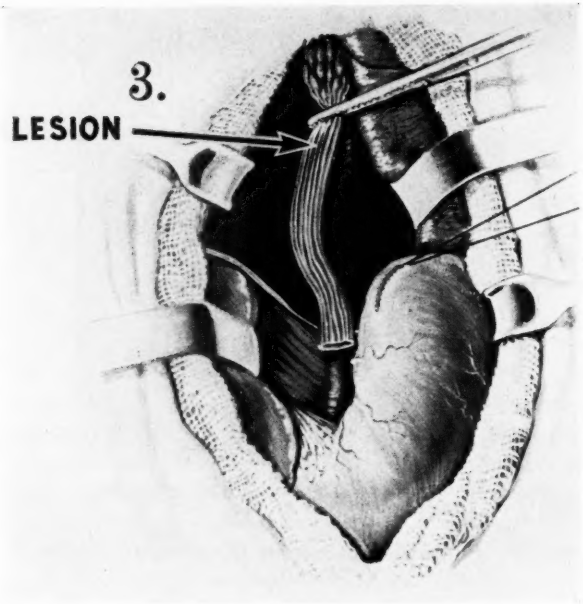

Fig. 3.—The esophagus has been severed from the stomach and the cardia closed. The clamp, applied to the inferior border of the tumor, is released and the lumen of the esophageal mass is permitted to drain into the pleural cavity.

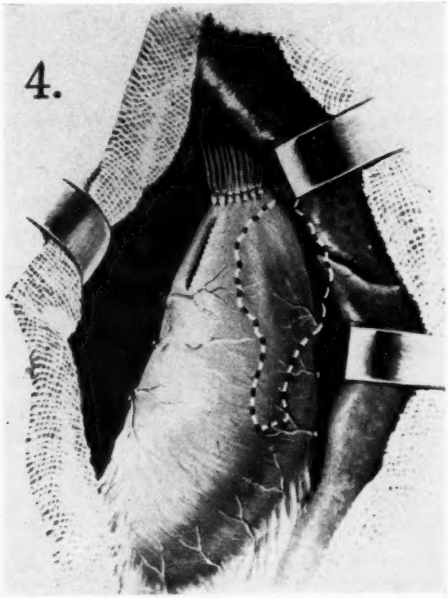

Fig. 4.—The stomach is anastomosed to the distal end of the proximal portion of the esophagus above the nonresectable malignant lesion. Note the stomach takes a position anterior and lateral to the tumor, which is left in situ.

or fourth intercostal space. Dissection was carried through into the right pleural space, the mediastinal pleura was divided, and the esophagus exposed. The extent and the operability of the lesion could then be readily determined. If definitive surgery is possible, the incision is continued by spliting the sternum (Figs. 1 and 2) and dividing the abdominal linea alba to the umbilicus (Figs. 3 and 4).

This incision is selected for several reasons. The supine position is the most physiologic one for respiration and reduces to a minimum the hazard of an increased carbon dioxide concentration in the blood. Moreover, through this incision, not only is the depth of the wound considerably less than with the posterolateral exposure, but the esophagus and stomach are more readily exposed. Furthermore, in the presence of an adherent tumor there is greater danger with the left posterolateral approach of injuring or tearing the azygos vein, aorta, or bronchus.

Another consideration is that a relatively short anterior incision is made in the diaphragm. Consequently the function of the diaphragm is less impaired, which is important in this age group of patients.

The proposed incision also has a distinct advantage over the combined abdominothoracotomy. In making the combined exposure, the abdomen is first opened to free the stomach. Thus, the surgeon is committed to a major operation before determining the resectability of the growth. In addition, when the patient is turned on his side for the second stage, he is exposed to the increased hazard of carbon dioxide accumulation.

The disadvantages encountered by the anterior thoracotomy are (1) the need for two assistants, and (2) the necessity of anteriorly retracting the lung which, if not handled with care, may be injured.

The postoperative care of these patients is equally as important as the preoperative preparation. Because of the inevitable atonia of the stomach due to the bilateral vagotomy, we prefer our patients return from the operating room with a Levine tube inserted into the stomach. The drainage from the Levine tube is accurately measured, for it provides an excellent index as to the electrolyte and water loss from the upper gastrointestinal secretion. Considerable amounts of sodium, potassium, and chlorides may be lost in this manner, and occasionally a patient may experience cardiac arrhythmia or other physiologic disturbances from these losses.

The need of maintaining fluid and electrolyte balance is of the utmost importance. Although the ideal supportive measures are not completely understood at the present time, certain factors seem to be evident. It is relatively well known that when the cells of the body are subjected to trauma, they seem to retain water and lose potassium. It has been our policy to limit fluid postoperatively to 1,000 to 2,000 c.c. on the first and second days, since there is a compensatory sodium and water retention by the body. Following the first two postoperative days, the patient receives a total fluid, which is determined by the loss in gastric drainage, in the form of Hartmann's or Ringer's solution plus 2,000 c.c. of 5 per cent glucose in water. Therefore, a patient with 1,000 c.c. of gastric drainage receives a daily total of 3,000 c.c., consisting of 1,000 c.c.

of Ringer's or Hartmann's solution and 2,000 c.c. of 5 per cent glucose in water. In the final analysis, the urinary output is the gauge determining whether more or less water is required by the body. With a low urinary output, highly concentrated, as shown by a high specific gravity, the total fluid administration should be increased.

The four patients in whom the lesion was left isolated and intact are reported below.

CASE REPORTS

CASE 1.—A 62-year-old white man was admitted to the hospital complaining of substernal pain and progressive dysphagia of eight months' duration, with a weight loss of thirty pounds. The patient was in fair physical condition. Esophagoscopic examination and biopsy, however, confirmed the impression of carcinoma in the upper middle third of the esophagus. There was no bronchoscopic evidence of bronchial invasion.

We were confident this lesion was resectable. Inadvertently the abdominal portion of the operation was completed before determining the intrathoracic extent of the growth. A thoracotomy incision was made through the right third intercostal space. It was found that the tumor had so circumscribed the aorta that it did not appear resectable, so we proceeded with the intention of removing this mass by the "grubbing-out technique." In order to obtain better exposure and facilitate removal of the tumor, the sternum was split so that the abdominal and thoracic incisions were connected. Because of the extension of the tumor into both pleural cavities with fixation to the aorta, and since the patient was not doing well, we were compelled to isolate the involved segment of the esophagus and leave it in situ. The stomach was then anastomosed to the proximal segment of the esophagus.

Closure of the abdominal and thoracic wounds was done in the customary manner, and the sternum was reapproximated with steel wire. One intercostal drain was used and connected to a water-sealed jug. The patient developed no signs or symptoms suggestive of mediastinitis or empyema. The only disturbing postoperative complication was a drug sensitivity. He was discharged sixteen days after operation, in a fair condition. One year later the patient was in a poor state of nutrition and complaints of pain and malaise were variable and severe.

Comment.—Much surgery was done on this patient without removing the disease which will eventually kill him. When malignancy of the esophagus has progressed this far, we can do very little except to alleviate symptoms, but in certain cases we are justified in doing extensive surgery to accomplish even this result.

CASE 2.—A 53-year-old housewife had minor symptoms of dysphagia for three months and had lost thirty-six pounds. In recent weeks even liquids were regurgitated. This patient was in a poor state of nutrition, but further physical examination was not revealing. Roentgenograms showed an obstructive lesion in the upper part of the middle third of the esophagus. Esophagoscopic biopsy showed a squamous-cell carcinoma. By bronchoscopy, it was thought the bronchus was not intrinsically involved.

Later, through a right third intercostal incision, the mediastinal mass was found to be hopelessly nonresectable; it was intimately attached to the aorta and the posterior surface of the bronchus. The sternum was then split in the midline and the incision extended to the umbilicus, and the diaphragm was opened to the esophageal hiatus. After the stomach was freed of its vascular attachments, the lower portion of the esophagus was dissected out of the mediastinum. The mass was isolated by severing the esophagus proximally and distally to the growth. The distal end of this malignant mass was left open. With the lung retracted anteriorly, the stomach was anastomosed to the proximal portion of the esophagus.

The diaphragm was closed with interrupted cotton sutures. Both abdominal and chest wounds were closed in the usual manner, with the sternum being held in place with stainless steel wires. One posterior mushroom catheter was connected to a water-sealed jug.

The patient's postoperative course was interrupted by hypochloremia, which was controlled with intravenous potassium chloride. This patient developed no signs of intrapleural infection. Under protest, she went home thirteen days after operation. There were no swallowing difficulties although she had a complete anorexia and remained in a very poor nutritional state. On three occasions she was readmitted to the hospital because of starvation symptoms, but always refused to stay but a few days. She remained bedridden and died at home six months after operation. There was no autopsy.

Comment.—As is true in this case, we have to rationalize as to why we operate on such poor, miserable souls. After investigating the sociologic and economic background of this individual, it was quite apparent that neither she nor her stepchildren could manage the simple feeding through a polyethylene tube. However, the justification of extensive surgery for only six months of miserable existence is debatable.

CASE 3.—A 64-year-old white man had the complaints of dysphagia for four months' duration, with only eight or ten pounds of weight loss. This patient was in an unusually good physical condition, as he had not undergone the usual deterioration that is seen with malignancy of the esophagus. Esophagoscopic and bronchoscopic examination with biopsy established the diagnosis and disclosed fixation of the trachea at its bifurcation. Upon exploration through a left thoracoabdominal incision, the mass was found to be adherent to all surrounding structures and nonremovable.

The stomach and the lower end of the esophagus were freed, the esophagus was severed at the proximal and distal ends of the neoplasm, and the stomach was anastomosed to the proximal esophageal segment. Radon seeds were placed in the tumor, and it was left intact. The patient's postoperative course was not remarkable, and he was discharged sixteen days after the operation. Effler[3] reported that this patient lived fourteen months before dying of extensive carcinomatosis.

Comment.—This individual was able to "carry on" quite well for approximately twelve months. It is significant to note that even though a malignant mass with all its necrosis drained into the pleural cavity, no intrapleural infection developed.

CASE 4.—This 64-year-old white woman had swallowing difficulties ten months before seeking relief. She denied much weight loss, though she was poorly nourished and obviously underweight. Careful preoperative conditioning on a medical regimen was required before this individual was explored through a left thoracoabdominal approach. There was extensive local spread and the mass was "frozen" to its surrounding structures and was thus hopelessly nonresectable. The esophagus was severed at the proximal and distal ends of the tumor, after which the stomach was anastomosed to the esophagus, with the lesion left intact in the mediastinum. The patient did not develop empyema or other symptoms of intrathoracic infection. She had many electrolytic and nutritional problems after the operation, but was discharged within seventeen days. She survived without appetite and with substernal pain for ten months.[3]

Comment.—It is most disturbing to the surgeon, but even more distressing to the patient, to learn that after extensive surgery he is able to swallow but unable to eat because of loss of appetite. The alteration in peristalsis and the atonia of the stomach are probably the reasons for this appetite loss. Urecoline given subcutaneously and orally improves the loss of appetite in some patients, as we have recently experienced.

SUMMARY

In summary, we would like to emphasize three points: First, our present approach to the control of malignancy of the upper esophagus rarely permits early diagnosis and five-year cures. Second, the heroic and radical resection of the tumor in far-advanced cases with esophagogastrostomy leaves much to be desired. Third, surgeons can do very little except alleviate symptoms in cases so far advanced.

Conditionally and with reservations, we have proposed a by-passing operation in which the esophagus is anastomosed to the stomach and the tumor is left in situ. In four such cases, no intrathoracic infection developed.

Finally, we advocate x-ray-irradiation before undertaking extensive surgery, and we recommend the modified anterior thoracoabdominal incision in certain cases as described.

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A CASE OF SPONTANEOUS REGRESSION OF AN UNTREATED BRONCHIOGENIC CARCINOMA

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INCREASED experience with cases of bronchiogenic carcinoma has established tremendous differences in the behavior of these tumors. Some are indolent, slow-growing, well-differentiated, epidermoid carcinomas; others are rapidly progressing, entirely undifferentiated types of neoplasms.

Most experienced clinicians have observed authenticated cases of lung cancer which, over long periods of time, have not increased in size or caused symptoms. The indolent behavior of some pulmonary neoplasms, naturally, brings up the question of whether two- and three-year survivals following surgical intervention might not have depended more on the nature of the tumor than accomplishments of the operation.

The behavior of these tumors is compatible with Handley's[1] ideas expressed in 1909. He believed that every aggregation of cancer cells has a definite life cycle and that the cells might increase in size over a period of time and at a varying rate, but in some instances tended to undergo spontaneous degeneration and fibrotic changes. The tumor fails in its completion of the life cycle because in most cases death of the patient occurs before the cycle is completed.

Spontaneous regression of various types of malignant tumors has been reported but a review of the literature fails to reveal an authenticated case of spontaneous regression of bronchiogenic carcinoma. Most of the reports in the literature describe regressions of metastatic carcinomas of genital origin.[2-6]

Certain theoretical factors influencing spontaneous regression of neoplasms have been expressed by Rubens-Duval.[2] He considered autoimmunization and febrile episodes as the most important factors. High body temperature has long been considered an important factor in the regression of cancer. Patients have shown regression of carcinoma following attacks of erysipelas, smallpox, pneumonia, malaria and acute tuberculosis. Coley's serum was first employed because of this observation.

Unfortunately, practical application of hyperthermia or similar measures has not been successful in the treatment of malignant tumors.

The following case report of the spontaneous regression of an authenticated lung cancer is presented.

CASE REPORT

A 59-year-old white man was admitted to The George Washington University Hospital on May 19, 1947. The patient had been in good health until September, 1946, when he first noted an increase in a chronic cough which he had had for years. In addition, he

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gave a history of malaise and increasing dyspnea of two months' duration and an eighteen-pound weight loss over a period of six months.

The past history revealed that the patient suffered from chronic bronchitis of about twenty years' duration. He had smoked from two to three packages of cigarettes daily for many years. He gave a history of liberal alcoholic intake for about twenty-five years.

Physical examination revealed decreased breath sounds over both lung bases, particularly marked in the anterior right chest. No râles were heard. A left direct-indirect hernia was present.

Roentgenograms of the chest revealed an opacity in the right lung field at the level of the third and fourth intercostal spaces anteriorly (Fig. 1).

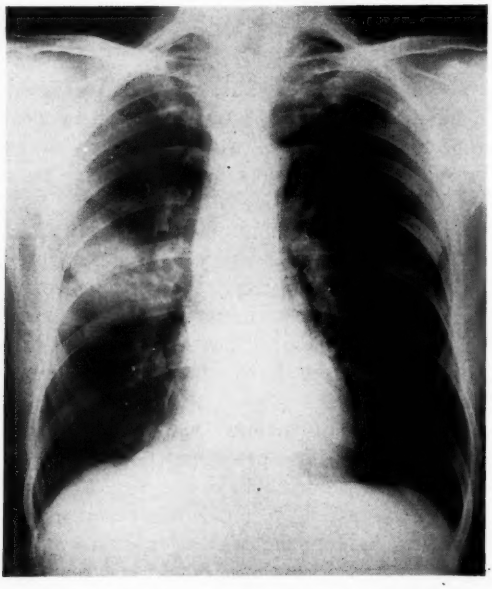

Fig. 1.—Roentgenogram of the chest made July 1, 1947, showing a lesion in the right lung.

Laboratory data demonstrated a slight leukocytosis and a moderate anemia. Further analyses were negative.

Examination with the bronchoscope failed to reveal abnormal tissue for biopsy examinations. A Papanicolaou stain of the bronchial secretions was not done.

The patient left the hospital but was readmitted on July 16, 1947. Appearance of the lesion on chest roentgenograms had not changed during this eight-week period. However, there was temperature elevation to 38.5° C. Forty-eight hours later, the temperature was normal.

On July 20, a right thoracotomy was performed which revealed a carcinoma of the lung with involvement of the right hilum and invasion of the mediastinum at the level of the inferior pulmonary artery.

A biopsy of the mass was taken and since the lesion appeared inoperable, the chest was closed. Microscopic examination of the tissue revealed an epidermoid carcinoma (Fig. 2).

Mitotic figures were present in all microscopic fields and there could be no question about the malignancy of the lesion.

The postoperative course was uneventful. The temperature remained elevated from 38 to 38.5° C. for the first three postoperative days and then returned to normal. The patient received 300,000 units of penicillin daily for five days. He was discharged on the ninth postoperative day.

During the postoperative period, roentgenograms of the chest revealed progressive clearing of the pulmonary lesion in the right lung. This became particularly apparent about six months after the exploratory thoracotomy. His general condition remained good.

The incredible behavior of the pulmonary lesion naturally aroused suspicion that there had been a mistake made in the histologic diagnosis and perhaps a mislabled specimen accounted for an erroneous diagnosis.

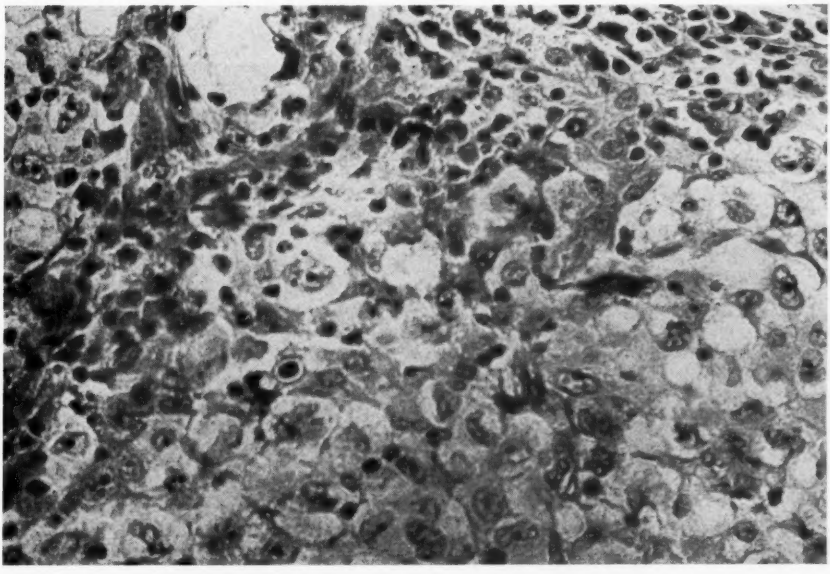

Fig. 2.—Photomicrograph of section of lung biopsy.

Accordingly, new sections were made which again revealed epidermoid carcinoma, and a careful check on the operative schedule for one week before and one week after the exploratory thoracotomy had been performed established that it was impossible for the specimen to have been misplaced since no other case of bronchiogenic carcinoma had been operated upon during that period. Moreover, subsequent developments, notably bone metastases, appeared to establish that the original lesion was malignant.

The patient was readmitted to the hospital on May 19, 1952, exactly five years after the original admission. A careful re-evaluation of his entire life history was undertaken in an effort to obtain any pertinent facts which might have influenced the behavior of the lung cancer. Nothing of significance could be found, except that for four or five years he had been employed as a linotype operator with exposure to noxious fumes. This ultimately led him to change his occupation. Following the operation, in 1947, he took two halibut liver oil capsules daily for a considerable period of time, four vegetable compound tablets daily, an occasional barbiturate for sleep, and vitamin B_1 tablets.

The vegetable compound tablets were analyzed and were found to contain asparagus, parsley, water cress, and broccoli.

Physical examination, five years after the lung cancer had been detected, revealed a thin white man, who appeared younger than the stated age of 64 years. No physical abnormalities could be detected, other than the left indirect hernia.

Laboratory studies included blood urea determination, nonprotein nitrogen, acid phosphatase, and alkaline phosphatase, all of which were within normal limits. The total proteins were 5.75 Gm. per cent with an albumin-globulin ratio of 1.56, albumin 3.50 Gm. per cent and globulin 2.25 Gm. per cent. Blood cholesterol was 238 mg. per cent, and cholesterol esters 48 per cent. The blood sugar was 78 per cent and serum amylase 40 per cent. Multiple agglutinations were negative. Liver function studies were within normal limits. Eosinophil determination was 122/mm.^{3} before ACTH and 56/mm.^{3} after ACTH. An electrocardiogram was within normal limits. Ketosteroid excretion was: 1,180 c.c. - 4.4 mg. per twenty-four hours; 2,820 c.c. - 10.7 mg. per twenty-four hours; 880 c.c. - 7.9 mg. per twenty-four hours. The normal value for a man of the patient's age is from 5 to 15 mg. per twenty-four hours.

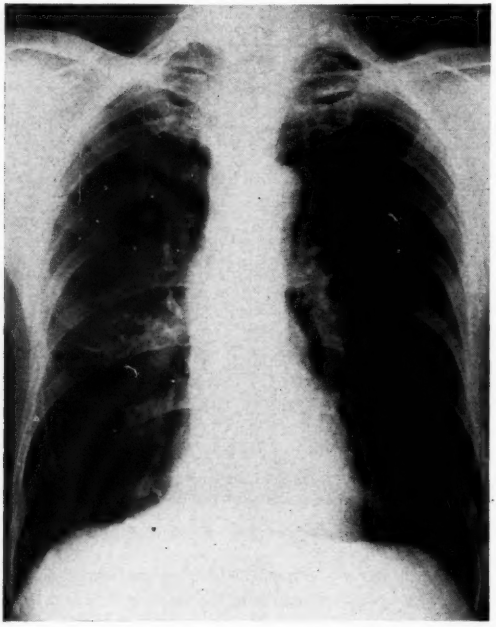

Fig. 3.—Roentgenogram of the chest made Dec. 10, 1952, demonstrating the almost complete disappearance of the lesion in the right lung.

Roentgenograms of the chest, skull, pelvis, spine and femurs were obtained.

Significant changes were found on the roentgenograms of the chest. There was a 3 cm. irregular density in the left second interspace anteriorly, which had not been present on previous chest films. The almost complete disappearance of the original lesion in the right lung was constant, corresponding to roentgenograms of the past four years (Fig. 3).

In the lateral view of the skull a destructive lesion could be demonstrated in the occipital bones. The remainder of the survey of the bones revealed no metastatic lesions.

The patient was discharged from the hospital after these procedures and was seen again on Dec. 10, 1952. Roentgenogram of the chest at that time revealed no change from the x-ray obtained in May, 1952.

COMMENT

No explanation has been found for the regression of this lung cancer. The postoperative temperature elevations were not high and cannot be regarded as significant. Drugs used by the patient are not considered important and, as far as it is known, have no carcinolytic properties.

This case represents the only known instance of spontaneous regression of a bronchiogenic carcinoma. Despite evidence of metastasis to the skull, the patient remains in good health more than five years after the original diagnosis of bronchiogenic carcinoma.

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THE FATE OF PATIENTS WITH ALVEOLAR-CELL TUMOR OF THE LUNGS

THOMAS W. MEARS, M.D.,* JOHN W. KIRKLIN, M.D.,** AND LEWIS B. WOOLNER, M.D.,*** ROCHESTER, MINN.

ALVEOLAR-CELL tumor has remained an unsolved problem since the first description of this interesting pathologic lesion by Malassez[1] in 1876. The purpose of this paper is to review the fate of patients whom we have treated at the Mayo Clinic for alveolar-cell tumor. At the clinic we first treated a patient having this condition by surgical excision in 1943. Since that time we have treated twelve additional patients surgically. Reports of seven of our thirteen cases have been published previously.[2, 3]

PATHOLOGIC ASPECTS

It is not our purpose to discuss in detail the pathologic characteristics of alveolar-cell tumor. We feel, however, that we must describe the lesion we identify by the term "alveolar-cell tumor of the lung." In all our cases we have carried out careful gross and microscopic re-examination of tissue removed at the time of operation. In all cases the lesion is thought to be primary in the lung. We have excluded any case in which primary adenocarcinoma occurred in any other part of the patient's body.

Alveolar-cell tumor involves varying amounts of the lung and on gross examination firm nodules are found which range in size from that of a millet seed to complete involvement of a lobe. Cut sections of these nodules appear similar to the gray hepatization stage of pneumonia. Mucoid material often can be expressed and may be abundant. The histologic pattern of this tumor also is variable. The microscopic sections will show the alveolar septa to be lined by nonciliated columnar cells which show papillary projections into the alveolar spaces. The cytoplasm of the cells is either clear or stained pink. Some cells contain mucus which frequently is secreted into the alveolar spaces. In the simplest form, the cells are remarkable for their monotonous regularity of form, arrangement, and staining qualities (Fig. 1, *a*). Histologically, however, considerable variation may be observed on studying multiple sections of a given lesion. Thus in some cases the typical alveolar pattern with relatively benign-appearing cells was present in large portions, but careful search revealed small foci of anaplastic cells within the tumor in which the pulmonary architecture was no longer preserved (Fig. 1, *b*).

The literature on the pathology of alveolar-cell tumor is abundant, but still opinions differ as to whether the tumor originates from epithelial or mesenchymal elements; in fact, there is no agreement that the tumor has a multicentric origin.

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Although most writers seem to support the multicentric theory of origin for these tumors, Herbut,[4] in 1944, suggested that the lesion described as alveolar-cell tumor had a primary focus and that intrapulmonic metastasis from this focus could account for the gross pattern of these tumors. In 1949, Smith, Knudtson, and Watson[5] reported that they had been able to trace extension of neoplastic cells along the perivascular lymphatics to distant nodules of tumor. They also suggested that the multiple nodules of tumor could represent intrapulmonic metastasis from a primary focus rather than nodules with a multicentric origin.

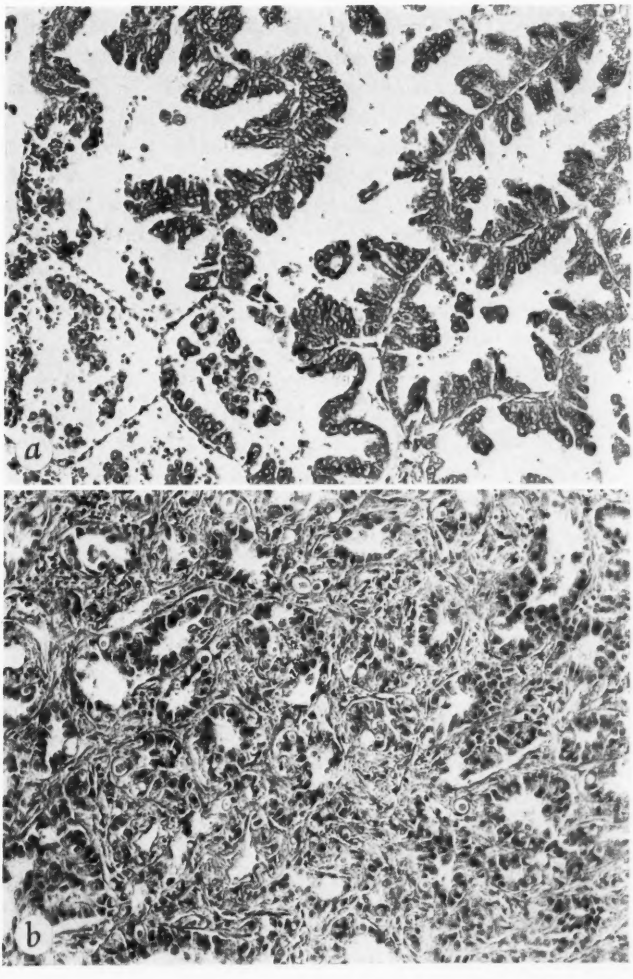

Fig. 1.—Alveolar-cell tumor of lung. *a*, Typical histologic appearance showing alveoli lined by tumor cells. *b*, Section from a different portion of same specimen. Note loss of alveolar pattern.

Of our thirteen patients, ten were women and three were men. The average age was 51.8 years, and their ages ranged from 30 to 66 years.

SYMPTOMS

Three patients did not have any symptoms referable to the thorax on primary examination. Instead the tumor was found on roentgenologic examination of the thorax carried out as part of the general examination. The average duration of symptoms in the other ten patients was eleven and one-half months with a range of one and one-half to twenty-four months. Cough was the commonest symptom and was described by some patients as persistent and by others as intermittent. Varying amounts of sputum were raised. In most instances, however, coughing produced a frothy clear sputum as the disease progressed. Another common symptom was dyspnea, which was usually described as exertional in nature. In the case of one patient, who complained of exertional dyspnea, nocturnal dyspnea also gradually developed as the disease progressed. Fever, which varied from bouts of chills and fever to a minimal elevation of temperature in the afternoon, was a symptom described by six patients. Pain in the thorax and hemoptysis were complaints in five cases. Only three patients mentioned loss of weight.

PHYSICAL AND ROENTGENOLOGIC EXAMINATIONS

The physical examination was of little clinical significance except for the fact that depressed breath sounds were heard over the affected area.

The roentgenologic examination of the thorax may show a small, poorly defined region of consolidation in the lungs which appears to be pneumonitis. As the disease progresses, other portions of one or both lungs may become involved. In the advanced stages both lungs are involved with multiple foci which frequently become confluent and give the appearance of a mass or of a consolidated lobe.

In each of our cases the lesion was demonstrated on roentgenologic examination of the thorax. Our studies agreed with those of other authors on this subject, in that characteristic findings which could be considered diagnostic were not found.

BRONCHOSCOPIC AND CYTOLOGIC ASPECTS

Bronchoscopic examination was done in each case. The gross findings at the time of bronchoscopy were significant in eight cases. A frothy mucoid material was described coming from the involved segments of the bronchial tree in five cases and some deformity of a bronchus was noted in three cases. Biopsy was done at the time of bronchoscopy in four cases. In one of these positive evidence for carcinoma was found, and the pathologist suggested the possibility of an alveolar-cell tumor.

Preoperative cytologic examination was done in eleven cases. Malignant cells were found in either or both the sputum and bronchial washings in seven (63.6 per cent) cases.

The sputum should be examined postoperatively for malignant cells in order to ascertain whether all the involved lung has been removed. At times groups of malignant cells will be found in the sputum after operation indicating that small foci of neoplastic tissue remained which were of insufficient size to be detected roentgenologically or grossly at operation.

TREATMENT

Neubuerger and Geever[6] reported that 50 per cent of their patients had metastasis, and in half of these distant metastasis was present. Only one of our patients showed spread to the hilar lymph nodes at the time of operation. Although necropsy was not done, this patient also showed evidence of cerebral involvement before death five and one-half months later. Infrequently, the disease apparently remains localized to one lobe for a period of months or years.

The extent of resection should be as conservative as possible and yet all neoplastic tissue should be adequately removed. Lobectomy was the operation of choice in ten cases, and pneumonectomy was carried out three times. It is of interest to note the preponderance of operative procedures on the left lung. The lower lobe was resected in eight cases and the upper lobe in two. The right upper lobe was removed in two cases and all three pneumonectomies were on the right side.

Two patients had second operations for this disease. One had recurrence of symptoms plus roentgenologic evidence of recurrent tumor in the lower lobe of the left lung. This lobe was resected completing the pneumonectomy. Subjectively, this patient improved, but the sputum remained positive for malignant cells postoperatively. At the time of this writing, she has further evidence of a tumor in the right lung and her condition is becoming worse steadily.

The other patient had the right upper lobe removed at a second-stage procedure two and one-half months after removal of the left lower lobe. She died in the postoperative period of pulmonary edema. Necropsy did not show evidence of residual tumor in the remaining portions of the lungs.

Roentgen therapy was used in addition to surgical excision of the lesion in four cases, but the course of the disease evidently was not altered in any of these people. All are now dead of their disease.

Other methods of therapy have been described in the literature including the use of nitrogen mustard[4, 7] and of Teropterin.[4] In each case apparent beneficial effects were not obtained.

Results of treatment in these cases have been very disappointing. Fifteen operations were carried out on the thirteen patients, and two deaths occurred in the immediate postoperative period. Only four of our thirteen patients are living at the time of this study and two of these have evidence of recurrent tumors. Of the two patients who are living and who do not show evidence of recurrence, one has survived operation four years and the other one year. Although as yet none of our patients has survived five years, cases of a few five-year survivors are reported in the literature. Five of the nine patients who died showed evidence of recurrent disease. Two patients died in the immediate postoperative period and necropsy did not show evidence of residual tumor in

either case. Two patients who survived the operation died of other causes. One had Hodgkin's disease and the other one died suddenly of unrelated disease. Necropsy was not done on the latter patient, but when seen at the clinic about six months prior to death, recurrence of the tumor was not evident.

Even though this method of treatment is only palliative to most patients, the few who have been treated in this manner and who have survived this dreadful disease still encourage us a bit. We are of the opinion that the patient should not be denied operation even though too often the disease will recur in a previously normal-appearing lung, and the patient will eventually die as a result of asphyxia, metastasis, or pneumonitis.

SUMMARY

We have reviewed our experiences with the treatment of ten women and three men who had alveolar-cell tumor of the lungs. The average age was 51.8 years.

Three patients in our group did not have symptoms referable to the thorax when they were first examined. The average duration of symptoms in the remaining ten patients was eleven and one-half months. The commonest symptoms were cough, dyspnea, fever, pain in the thorax, and hemoptysis. The lesions were demonstrated on roentgenologic examination of the thorax, but their appearance was not diagnostic.

The usual significant finding at bronchoscopy was a frothy mucoid sputum coming from the involved segments of the lung. Either the bronchial washings or the sputum or both were positive for malignant cells in 63.6 per cent of the cases in which cytologic examination was done.

Although the results of treatment are disappointing, the only method of treatment of even palliative value at the time of this study is conservative surgical excision of the affected portions of the lung.

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THE USE OF DIRECT PRESSURE MEASUREMENT AT THE OPERATING TABLE TO EVALUATE THE ACUTE RESULTS OF CORRECTIVE CARDIAC SURGERY

HENRY A. ZIMMERMAN, M.D.,* AND EARLE B. KAY, M.D.**
CLEVELAND, OHIO

THE ability to differentiate and clarify congenital cardiac anomalies into separate entities has progressed rapidly with the advent of cardiac catheterization and angiocardiography. This increase in understanding of such anomalies has reflected itself in the perfection of techniques for surgical correction.

However, a group of anomalies remains where the diagnosis can only be suspected and verification must await surgical exploration. During cardiac catheterization, at times, the catheter cannot be introduced into the pulmonary artery or into the right ventricle. Hence, differentiation between pulmonic stenosis, atrial, and ventricular septal defects, and the combination of these conditions may be impossible. During the past two years, the use of direct pressure measurements at the operating table has frequently allowed this differential diagnosis to be made.

Also in cases of pulmonic or infundibular stenosis the exact portion of the stenosis can be determined by obtaining the pressure differential proximal and distal to the point of obstruction. This information is of the utmost value to the surgeon in determining the site of the myocardotomy and the technique to be employed.

Fig. 1.—The Photron single channel direct-writer and the Photron strain gauge analyzer with a Statham pressure transducer. Notice the portability of this equipment.

From the Cardiovascular Laboratory, St. Vincent's Charity Hospital.
Received for publication Jan. 4, 1954.
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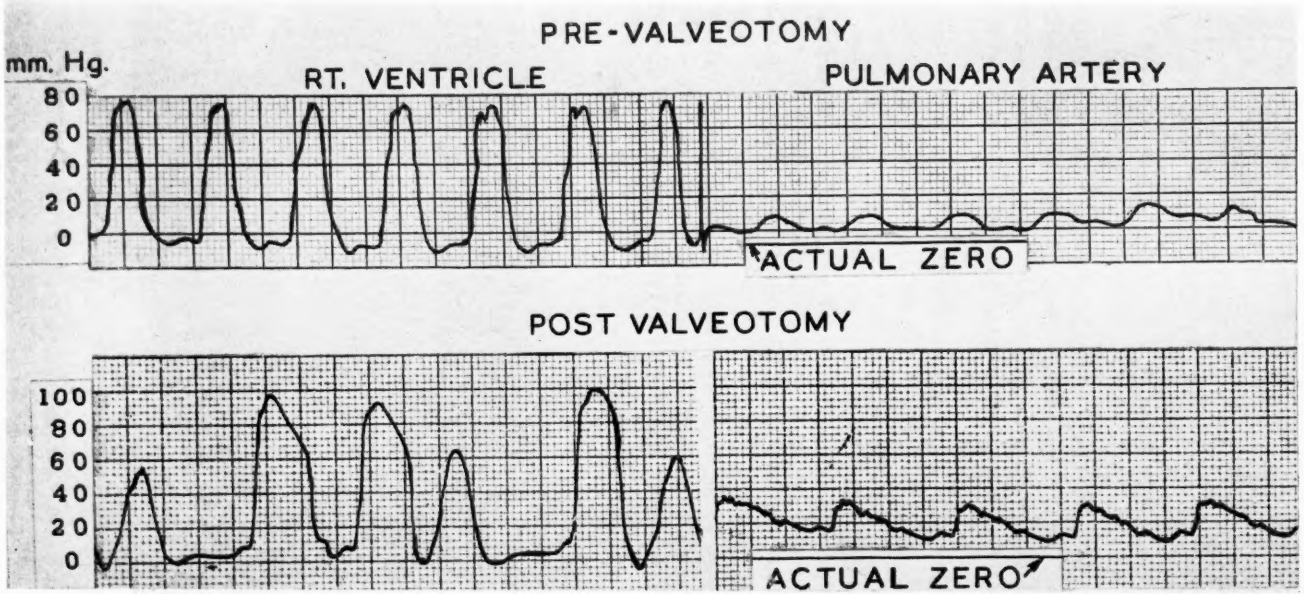

Fig. 2.—The pre- and postvalvulotomy pressures on a 28-year-old white man with a tetralogy of Fallot. Note: Following valvulotomy the pulmonary artery pressure is doubled and the pressure curve resembles more that obtained in a normal pulmonary artery as compared with the damped curve taken before valvulotomy.

The apparatus that is used consists of a Statham pressure transmitter filled with aqueous Zephiran chloride 1 per cent, and the nub of the gauge filled with heparin, 10 mg. per cubic centimeter. The gauge is immersed in a 1 per cent aqueous Zephiran chloride, 1 per cent solution, and allowed to soak from twenty to thirty minutes; the gauge and lead-in wires are covered with two layers of sterile stockinette, through which the sterile nub protrudes and this is, in turn, connected to a 22 or 23 gauge needle or a Beck-Dickerson arterial needle which is placed in the desired area to record pressures. Pressures are then recorded by means of strain gauge amplifiers of the Photron or Sanborn type; these feed the signal into a single or double channel Photron or Sanborn direct writing recorder.

By means of an antenuator setting on the strain analyzer, the sensitivity of the gauge can be varied to record any pressure 0 mm. Hg up to 500 mm. of Hg. The pressure curve can be adjusted for maximal swing.

The equipment is quite mobile and especially the Photron instrument equipment which consists of a small pen motor in a separate case and a strain amplifier with the gauge connected in another case (Fig. 1). This can be carried from operating room to operating room or from hospital to hospital in a small carrying case.

It is also possible by this method to determine immediately the effectiveness of the surgical procedure in cases of pulmonic or infundibular stenosis. If the pressure has not been sufficiently reduced in the right ventricle and elevated in the pulmonary artery, this information can be immediately obtained and the condition remedied. It is interesting to note how frequently it is necessary to re-enter the heart and to improve the size of the stenotic area before equalization of pressures is obtained that would not have been accomplished without the benefit of direct pressure measurements taken at the time of surgery.

This procedure can be done with a minimal amount of time expenditure and yet gives the operator a very objective method of evaluating his immediate operating results in the form of hemodynamic changes, which should, for all intents and purposes, predict his long-range results.

Fig. 2 illustrates the case concerning a 28-year-old man with a tetralogy of Fallot, who had a pulmonary valvulotomy performed. Note the graduation in the return of the pulmonary pressure curve to normal following corrective surgery as the opening in the stenotic valve increased in size.

CONCLUSIONS

1. A simple method for taking direct pressures at the time of cardiac surgery is described.

2. This procedure aids in the differential diagnosis of congenital heart lesions.

3. It determines the site of stenosis in patients with pulmonary or infundibular stenosis, and whether the stenosis is sufficiently opened following corrective surgery.

THE AMERICAN ASSOCIATION FOR THORACIC SURGERY

THIRTY-FOURTH ANNUAL MEETING
MAY 3, 4, AND 5, 1954, SHERATON-MT. ROYAL HOTEL,
MONTREAL, CANADA
PROGRAM

Monday Morning, May 3, 1954

8:30 A.M. BUSINESS MEETING

9:00 A.M. SCIENTIFIC SESSION—Regular Program

1. **Lipid Deposition in Pulmonary Tissue.**
   William R. Waddell (by invitation), Ronald C. Sniffen (by invitation), and Lawrence L. Whytehead, (Travelling Fellow of the Association) (by invitation), Boston, Mass.
2. **Absence and Hypoplasia of a Pulmonary Artery Unassociated With Congenital Heart Disease.**
   Herbert C. Maier, New York, N. Y.
3. **Surgical Reconstruction of the Superior Vena Cava.**
   J. Gordon Scannell and Robert S. Shaw (by invitation), Boston, Mass.
4. **Stilbamidine as an Adjunct to the Surgical Treatment of Pulmonary Blastomycosis.**
   Page W. Acree (by invitation), New Orleans, La.
5. **The Conservative and Surgical Management of Benign Strictures of the Esophagus.**
   Paul H. Holinger, Kenneth C. Johnston (by invitation), Willis J. Potts, and Fernando daCunha (by invitation), Chicago, Ill.
6. **A Method of Preventing Peptic Esophagitis Following Esophagogastrostomy: Experimental and Clinical Study.**
   David H. Watkins (by invitation), Arthur Prevedel (by invitation), and Fred R. Harper, Denver, Colo.

Monday Afternoon, May 3, 1954

2:00 P.M. SCIENTIFIC SESSION—Regular Program

7. **Opportunities for Research in Thoracic Surgery With the Use of Tissue Culture Methods.**
   C. M. Pomerat (by invitation), Galveston, Texas
8. **The Results of Treatment in Carcinoma of the Lung.**
   David P. Boyd, Howard B. Kirtland (by invitation), Magnus I. Smedal (by invitation), and John G. Trump (by invitation), Boston, Mass.
9. **A Clinical Survey of Adenomas of the Trachea and Bronchus in a General Hospital.**
   Lamar Soutter, Boston, Mass.
10. **Palliation of Esophageal Obstruction Due to Carcinoma With a Permanent Intra-Luminal Tube.**
    S. A. Mackler and Roland Mayer (by invitation), Chicago, Ill.
11. **Studies on Cardiac Arrest: The Relationship of Hypercapnia to Ventricular Fibrillation.**
    Will C. Sealy, W. Glenn Young (by invitation), and Jerome S. Harris (by invitation), Durham, N. C.
12. **The Physiology of Hypothermia and Its Application to Cardiac Surgery.**
    W. G. Bigelow (by invitation), Toronto, Ont.

Tuesday Morning, May 4, 1954

8:30 A.M. SCIENTIFIC SESSION—Thoracic Surgical Forum

13. **Use of the Endotracheal Tube in Pulmonary Edema.**
Watts R. Webb (by invitation) and Guy D. Campbell (by invitation), Sanatorium, Miss.

14. **A Satisfactory Shunting Technique for Surgery of the Aortic and Pulmonary Valves and Proximal Great Vessels.**
Frederick S. Cross (by invitation) and Earle B. Kay, Cleveland, Ohio

15. **The Closure of Interventricular Septal Defects in Dogs During Open Cardiotomy With the Maintenance of the Cardiorespiratory Functions by a Pump Oxygenator.**
Bernard J. Miller (by invitation), Hans C. Engell (by invitation), Anthony R. Dobell (by invitation), and John H. Gibbon, Jr., Philadelphia, Pa.

16. **Studies of the Venous Collateral Circulation of the Lung.**
Alfred Hurwitz, Averill A. Liebow (by invitation), Paul Kunkel (by invitation), Massimo Calabresi (by invitation), and Ronald W. Cooke (by invitation), New Haven, Conn.

17. **The Physiological Basis for Utilization of Esophagocardiomyotomy in the Treatment of Achalasia—An Experimental Study.**
Paul Nemir, Jr. (by invitation), and H. R. Hawthorne (by invitation). Sponsored by Julian Johnson, Philadelphia, Pa.

18. **The Effect of Intrapericardial and Intracardiac Procaine Upon the Circulation in Man.**
E. M. Papper, Hugh Fitzpatrick (by invitation), Enzo Krahl (by invitation), F. F. McAllister (by invitation), and George H. Humphreys, II, New York, N. Y.

19. **Intracardiac Surgery With the Aid of Artificial Operative Tunnels.**
William K. Swann (by invitation), Jacob T. Bradsher, Jr. (by invitation), and Jorge Rodriguez-Arroyo (by invitation), Knoxville, Tenn.

20. **Cardioangiography.**
Philip W. Smith (by invitation), Hugh Craig (by invitation), and Karl P. Klassen, Columbus, Ohio

21. **Creation of Autogenous Vessels.**
Newton Chun (by invitation), Richard Forney (by invitation), and Egbert H. Fell (by invitation), Chicago, Ill.

22. **Experimental Esophagogastrectomy. Evaluation of Gastric Drainage Procedures Performed in Association With Esophagogastrectomy.**
Harold W. Neuman (by invitation) and F. Henry Ellis (by invitation). Sponsored by Herbert W. Schmidt, Rochester, Minn.

23. **Experimental Pedunculated Flaps Used for Cardiac Abnormalities in Dogs.**
Arnold E. Botwin (by invitation), Kansas City, Kan.

24. **Synchronous Combined Abdomino-Right Thoracic Approach for Carcinoma of the Middle Third of the Esophagus.**
Hawley H. Seiler (by invitation), Tampa, Fla.

25. **Differential Behavior of Arterial Homografts Implanted in the Thoracic and Abdominal Aorta.**
Edmund A. Kanar (by invitation), Lloyd M. Nyhus (by invitation), Horace G. Moore, Jr. (by invitation), Ralph K. Zech (by invitation), and Henry N. Harkins (by invitation). Sponsored by K. Alvin Merendino, Seattle, Wash.

26. **A Method of Supplementing the Coronary Circulation by a Jejunal Pedicle Graft.**
James A. Key (by invitation), Frederick G. Kergin, Yves Martineau (by invitation), and R. G. Leckey (by invitation), Toronto, Ont.

27. **Controlled Cross Circulation for Intracardiac Surgery.**
Herbert Warden (by invitation), Morley Cohen (by invitation), Raymond C. Read (by invitation), and C. Walton Lillehei (by invitation). Sponsored by Richard L. Varco, Minneapolis, Minn.

Tuesday Afternoon, May 4, 1954

2:00 P.M. EXECUTIVE SESSION—(Limited to active and senior members)

3:00 P.M. SCIENTIFIC SESSION—Regular Program

ADDRESS OF THE PRESIDENT—Emile Holman, San Francisco, Calif.

28. **The Surgery of Infundibular Pulmonic Stenosis With Intact Ventricular Septum (A Type of "Pure" Pulmonic Stenosis).**
Robert P. Glover, Hugo Gontigo (by invitation), Thomas C. McAuliffe (by invitation), Thomas J. E. O'Neill, and Robert E. Wells (by invitation), Philadelphia, Pa.

29. **Pulmonic Valvular Stenosis: Technic of Open Valvuloplasty and Results.**
Henry Swan, Henry C. Cleveland (by invitation), Helmut Mueller (by invitation), and S. Gilbert Blount (by invitation), Denver, Colo.

30. **Experiences in the Surgical Treatment of Aortic Stenosis.**
William H. Muller, Jr., Albert A. Kattus (by invitation), J. Francis Dammann, Jr. (by invitation), and Rodney T. Smith (by invitation), Los Angeles, Calif.

6:30 P.M. COCKTAILS AND DINNER—Sheraton-Mt. Royal Hotel.

ADDRESS BY GUEST OF HONOR—Dr. F. Cyril James, principal and vice-chancellor, McGill University, Montreal.

Attendance limited to members of the Association and their wives, invited speakers and their wives.

Dinner dress.

Wednesday Morning, May 5, 1954

9:00 A.M. SCIENTIFIC SESSION—Regular Program

31. **The Surgical Correction of Mitral Insufficiency by Valvular Suturing.**
Charles P. Bailey, W. L. Jamison (by invitation), H. T. Nichols (by invitation), and A. Bakst (by invitation), Philadelphia, Pa.

32. **The Surgical Correction of Mitral Insufficiency.**
Dwight E. Harken, Harrison Black, Laurence B. Ellis (by invitation), and Lewis Dexter (by invitation), Boston, Mass.

33. **Four Years' Clinical Experience With Internal Mammary Artery Implantation in the Treatment of Human Coronary Artery Insufficiency Including Additional Experimental Studies.**
Arthur Vineberg, D. D. Munro (by invitation), Herman Cohen (by invitation), and William Buller (by invitation), Montreal, Canada.

34. **Anatomic, Physiologic and Surgical Considerations in Closure of Atrial Septal Defects in Man.**
John W. Kirklin, Earl H. Wood (by invitation), Jesse E. Edwards (by invitation), and Howard B. Burchell (by invitation), Rochester, Minn.

35. **Aortic Arch Resection and Grafting for Aneurysm Employing an External Shunt.**
Allan Stranahan, Ralph D. Alley (by invitation), William H. Sewell (by invitation), and Harvey W. Kausel (by invitation), Albany, N. Y.

36. **Resection of the Thoracic Aorta With Replacement by Homograft for Aneurysms and Constrictive Lesions.**
Denton A. Cooley and Michael E. DeBakey, Houston, Texas.

Wednesday Afternoon, May 5, 1954

2:00 P.M. SCIENTIFIC SESSION—Regular Program

37. **The Viability of Tubercle Bacilli in Healed Tuberculous Lesions Following Long-Term Chemotherapy.**
Gladys L. Hobby (by invitation), Oscar Auerbach, Tulita F. Lenert (by invitation), Maurice J. Small (by invitation), and John V. Comer (by invitation), East Orange, N. J.

38. **Resection Surgery in Tuberculosis: Complications and After-History.**
Richmond Douglass, James M. Judd (by invitation), E. B. Bosworth (by invitation), and K. H. Chang (by invitation), Ithaca, N. Y.

39. **The Coordination of Surgery and Combined Chemotherapy in the Treatment of Pulmonary Tuberculosis.**
Alfred M. Decker (by invitation), James W. Raleigh (by invitation), and Edward S. Welles, Sunmount, N. Y.

40. **The Role of Pulmonary Insufficiency in Mortality and Invalidism Following Surgery for Pulmonary Tuberculosis.**
Edward A. Gaensler, David W. Cugell (by invitation), Jean M. Verstraeten (by invitation), Sylvia S. Smith (by invitation), and John W. Strieder, Boston, Mass.

41. **Experiences With Enlarging the Indications for Tracheal and Bronchial Grafts.**
Osler A. Abbott, Wm. E. VanFleit (by invitation), and Albert Roberto (by invitation), Emory University, Ga.

42. **Bronchial Anastomosis and Bronchoplastic Procedures in the Interest of Preservation of Lung Tissue.**
Donald L. Paulson and Robert R. Shaw, Dallas, Texas

CERTAIN ACTIONS TAKEN AT COUNCIL MEETING, MARCH 30, 1953

It was decided by the Council that the following actions should be published in the JOURNAL before the 1954 meeting of the Association:

"The Council reaffirms the attendance rule (By-Laws, Article IV, Sect. 7) which states that 'The Council shall recommend that any Active or Associate member . . . who has been absent without sufficient excuse from *three* consecutive annual meetings shall have his membership terminated.'

"The Council directs that attention to this rule be publicized during the coming year by publication in the JOURNAL, announcement at the Executive Session and circularizing the membership with a letter quoting the Council action. Mandatory adherence to this rule will be enforced beginning with the 1954 meeting of the Council."

RESOLUTIONS CONCERNING THE AMERICAN BOARD OF ANESTHESIOLOGY

The following resolution was passed by the Council and ordered published in the JOURNAL:

"Whereas, It has been brought to our attention that the American Board of Anesthesiology has declared and has exercised its right to withdraw its certificate of qualification from anyone who is not a member of the American Society of Anesthesiologists; and

"Whereas, This custom has worked great economic hardship on certain well-qualified anesthesiologists to whom the only objection raised was the method of receiving their compensation; and

"Whereas, In the opinion of the Council of The American Association for Thoracic Surgery this arbitrary custom is contrary to the best traditions of the practice of medicine and surgery; therefore be it

"Resolved, That the Council of The American Association for Thoracic Surgery express its disapproval of the action of any specialty board in attempting to exert economic pressure on anyone who has demonstrated his proficiency in the field by holding a certificate of the Board in question."

The American Board of Thoracic Surgery Has Requested That the Following Resolution Passed by It Be Published in The Journal of Thoracic Surgery:

"Certain trends, on the part of specialty boards and other medical organizations to prescribe the methods of compensation for medical services have created the necessity for the Board of Thoracic Surgery to define its objectives.

"The Board of Thoracic Surgery has no interest in whether its diplomates are compensated on a fee for case basis, a salary, or both.

"The purpose of the Board of Thoracic Surgery is to establish adequate standards of training in thoracic surgery and to conduct examinations to determine the qualifications of the candidates."

The 1955 Meeting of the Association for Thoracic Surgery Will Be Held April 24, 25, and 26 (Sunday, Monday, and Tuesday) in Atlantic City, New Jersey. The Headquarters Will Be at The Chalfonte-Haddon Hall.